MARCH 4, 1960

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MATERIALS AND PROCESSES

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One aircraft
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41 countries
516 hours
135,000 miles
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4,276 passengers
Jungle and mountain strips
Concrete, grass, sand

ROTAX TEST STAND FOR A.C. AND D.C. GENERATORS

The test stand shown gives precision test results on alternators up to 15 kVA, or D.C. generators up to 9 kW, over a speed range of 2,500 to 10,000 r.p.m. It can be supplied as a combined unit, with full instrumentation for testing both alternators and generators. With pressure gauges and flow indicators fitted, it is suitable for testing pumps, compressors and other hydraulic units.

- Unit to be tested, conveniently sited for observation whilst running.
- Test stand supplied complete with load banks and an air supply for cooling unit under test.
- Steel cabinet with hammered finish. Colour as required.

BIG RANGE... COMPLETE SERVICE

Rotax have developed a range of test stands for all types of generators and alternators and one should suit your needs. If you require a more specialised instrument Rotax engineers will be glad to advise you.

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ROTAX

For further information on Rotax test stands, please write or telephone:—Industrial Group, Rotax Limited
WILLESDEN JUNCTION, LONDON, N.W.10 (ELGar 7777)

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Products from SMITHS

AVIATION DIVISION

6

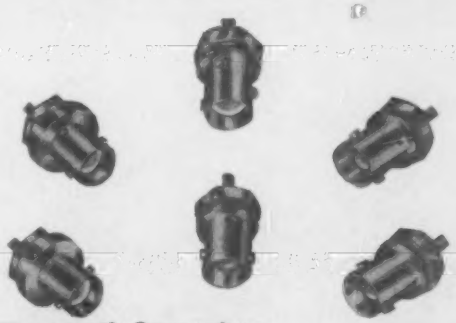
This is the last of a series of six insets which have appeared in this journal at intervals from March, 1959 onwards.

Kelvin Hughes Barometer, Station Type

For use by Aerodrome Control Towers and similar establishments, the Station Barometer is a sensitive altimeter calibrated to the I.C.A.N. Law to give maximum accuracy over its range of 0-10,000ft. or 0-5,000 metres. Both types have a barometric scale range of 800-1050 millibars. The instrument is fitted in a metal carrying case complete with correction card.

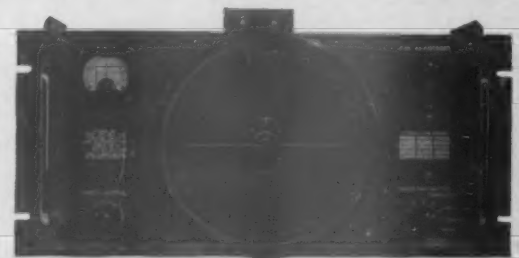
Smiths Brake Pressure Gauge

A wide range of direct reading Brake Pressure Gauges, including single, triple and quadruple pointer types, is available. The gauges are suitable for use with all types of pneumatic and hydraulic braking systems within their respective ranges.



Waymouth Connectors

A large range of connectors is available for cable mounting, panel mounting or bulkhead mounting. All connections are silver plated and will operate at temperatures up to 250°C. Available both in sealed and unsealed versions, the connectors have positive locking action which ensures vibration proof connection at all times.

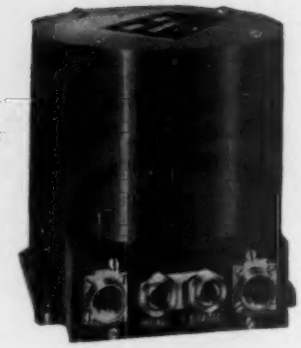


Kelvin Hughes Data Transmission Test Unit

This unit accepts 400 c.p.s. signals from various types of synchros and potentiometers and provides an accurate indication of angle. It may be used as a transmitter in a similar manner. An 8″ dia. dial calibrated 0-360° in ½ degree strips allows an overall accuracy of better than ¼ degree by having the "Null Meter" included on the front panel.

Smiths Ice Detector Head

Basically a pressure head with holes drilled in its leading and trailing edges and mounted vertically downwards. Under normal conditions this conveys a small positive pressure to the Ice Detector Relay but under icing conditions it exhausts the system. The resultant change in pressure in the Relay Unit is used to provide either visual warning or to operate the de-icing system. The Head incorporates a heater. Suitable for installation through pressure hulls.

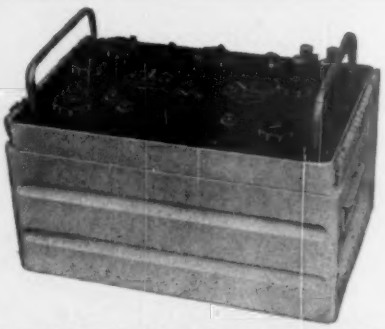


Smiths Ice Detector Relay

Used in conjunction with an Ice Detector Head, the relay forms part of an ice detector system which automatically gives warning or brings into operation de-icing equipment as soon as ice starts to form on vulnerable parts of an aircraft. Maximum total current consumption is 7.5 amps, 24v. D.C.

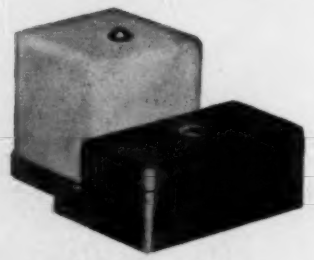
Kelvin Hughes Pitot/Static Head

The High Speed Pitot/Static Head, developed in collaboration with the Ministry of Aviation, is designed for use on transonic aircraft to provide an accurate source of Pitot and Static pressure throughout the speed range up to Mach numbers in excess of unity. Overall length of the head is 80" to ensure that airflow around the Pitot entry and Static slots is unaffected by the aircraft structure at high Mach numbers.



Kelvin Hughes Pitot/Static Test Unit

Designed to meet the requirement for highly accurate portable test equipment for use with modern pitot/static sensing devices such as Air Data Systems, this apparatus comprises two accurate pressure transducers, control valves, fine adjusting bellows, pitot head adaptor and dual purpose hand pump. Overall accuracy of both outputs is ±.015in.Hg.

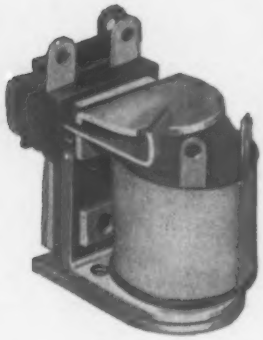


Waymouth Standard Double Pole Relays

Extensively used in aircraft electrical installations these relays are manufactured for general duty use in 6, 12 and 24v. D.C. circuits. The contacts are sintered silver nickel alloy and will carry 10 amperes at 24v. D.C. Robustly constructed and tropically finished, the units weigh 6 ozs.

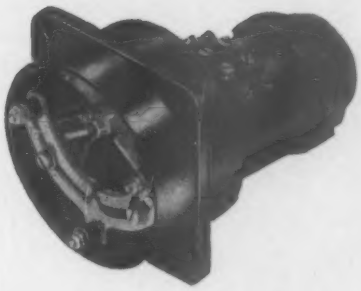
Waymouth Heavy Duty Single Pole Relays

For remote switching in aircraft circuits where a heavy current is involved, these relays are for use in 6, 12 and 24v. D.C. circuits. Tropically finished and mounted on a Bakelite base, the relays have heavy duty self cleaning copper contacts which will carry a maximum overload current of 50 amperes at 24v. D.C. Weight 4 ozs.



Waymouth Miniature Relays

Weighing only 1 oz. and having a cubic capacity of under 1 cu. in. these miniature relays are designed for operation in 6, 12 or 24v. D.C. circuits. Contacts are of rhodium flash and carry 1 ampere at 24v. D.C.



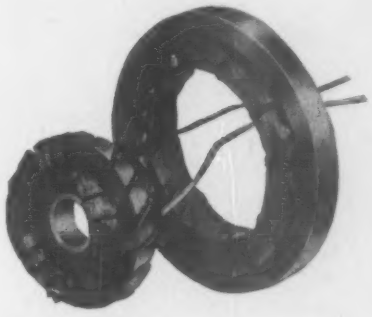
Smiths Torque Switch

Provides a means of detecting that the A.C. voltage is within the limits required to operate ancillary equipment using the 400 cycle supply. In conjunction with suitable relay circuits the Torque Switch can be used to automatically indicate failure or change over to stand-by supply in the event of supply failure.

COMPONENTS

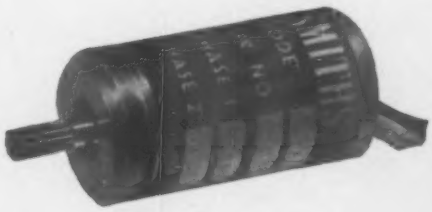
Smiths Synchros

The range of standard synchros includes control, torque, differential and resolver types in Size 11. All are of Grade 1 accuracy and are capable of operation in ambient temperatures up to 150°C.



Smiths Slab Synchros

Slab Synchros are available in Size 23 and are intended for use in gyro gimbal assemblies.



Smiths Servomotors

Standard servomotors include Sizes 07, 10, 11, 15 and 18. All these are available with any desired winding and some are also available in 50 C/S versions.

Smiths Generators & Motor Generators

A standard Size 11 Motor-Generator with high linearity and very low residual voltages. The generator will be available as a separate component.

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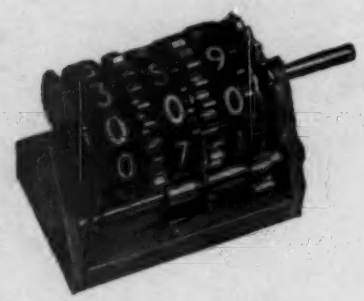


Smiths 360° Counter

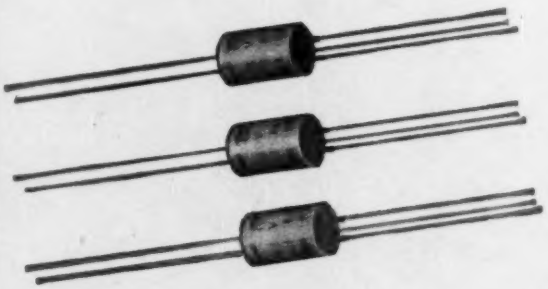
The smallest counter of its type indicating by three figure presentation angle of rotation of a shaft or for providing heading information on navigation equipment. The counter has large clear numbers and ½ degree divisions make for accurate reading. The instrument will function satisfactorily in the range of temperatures between —40°C and +70°C.

Smiths Gear Heads

These Size 11 gearheads provide compact gear reduction in conjunction with Size 07, 10 or 11 motors. They are notable for their low cost.

Smiths Rate Gyroscopes

Rate Gyros are available in two types covering requirements in missile, aircraft and marine use for small, highly robust, sensitive rate gyros. Life-hours between overhaul are as high as 3,000 hours.



Smiths Micro Relay

These newly developed relays measuring only 0.29 in. diameter and .475 in. long are capable of switching ½ amp. D.C. under severe conditions of heat and shock with high reliability.

Specially printed binders are available on request. Please write on your business letterheading for this binder. Additional copies of this inset and the previous ones can be sent direct to members of your organisation who require them. Please detail them on your application.

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Northrop is now producing the T-38 Talon for the U.S. Air Force Air Training Command. Pilots who have flown the T-38 agree that this is the plane in which the new generation of airmen can safely master the art of supersonic flight.

The twin jet T-38 is a member of the same low-cost and simplified-design family as Northrop's N-156F Freedom Fighter. Both incorporate similar performance characteristics and are powered by General Electric's J85 engines. Both reflect lower production costs, require only half the fuel to operate, and are far easier to maintain than aircraft of comparable performance. Both the T-38 trainer and the N-156F fighter are flying and ready for the Free World today.

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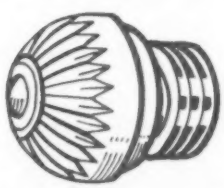
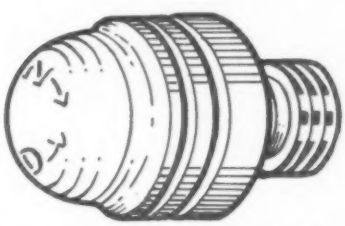
RAA.8

34 CIRCUIT VARIATIONS WITH THE *NEW* THORN 5-TERMINAL ILLUMINATED PRESS SWITCH

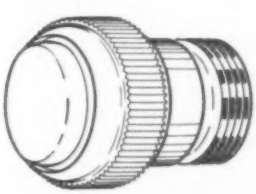
3 ALTERNATIVE CAPS



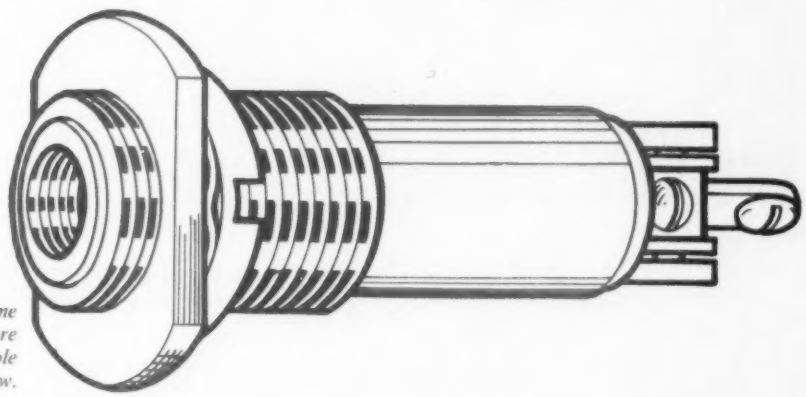
Transparent Indicator Cap in Polystyrene or Glass with surface facets to ensure visibility from all angles. Colours available Red, Green, Amber, Clear, Blue, Yellow.



Dimmer Cap in metal and glass with metal rotary shutter. Built-in stops restrict rotation between fully shuttered and open positions. Colours available, Red, Green, Amber, Clear, Blue.



Flat top Indicator in Polystyrene with engraving to order. Colours available Translucent Red, Amber, Green, White and Transparent Blue.



This extremely compact Illuminated Press Switch employs the now famous Atlas Midget Panel Lamp and by the incorporation of the 5-terminal arrangement, is capable of 34 circuit variations. As shown, three different caps can be employed for indicating or dimming purposes and each is available in a wide range of colours. The units are vibration proof, maintaining predetermined contact pressures and can be supplied for 6, 12 and 28 Volt circuits. Screw terminal or solder tag versions are available to order.

Overall dimensions:

with dimmer cap: $3\frac{1}{16}''$ x $1\frac{1}{16}''$ x $\frac{3}{4}''$ approx.
with indicator cap or
flat top indicator cap: $2\frac{7}{8}''$ x $1\frac{1}{16}''$ x $\frac{3}{4}''$ approx.

THORN 3-TERMINAL PRESS-TO-TEST FITTINGS

and Midget Indicator Lampholders are employed in Britain's leading civil and military aircraft and are widely used throughout the electronics and automation industries. The 5-TERMINAL ILLUMINATED PRESS SWITCH is a worthy addition to this range.

THORN ELECTRICAL INDUSTRIES LIMITED AIRCRAFT COMPONENTS AND CONNECTOR DIVISION
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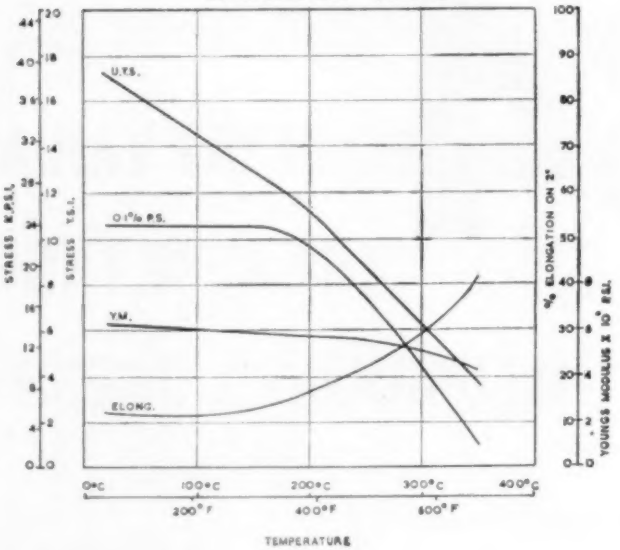
Thorn

EFFECT OF TEMPERATURE ON THE TENSILE PROPERTIES OF ROLLED ZTY (16 S.W.G.)



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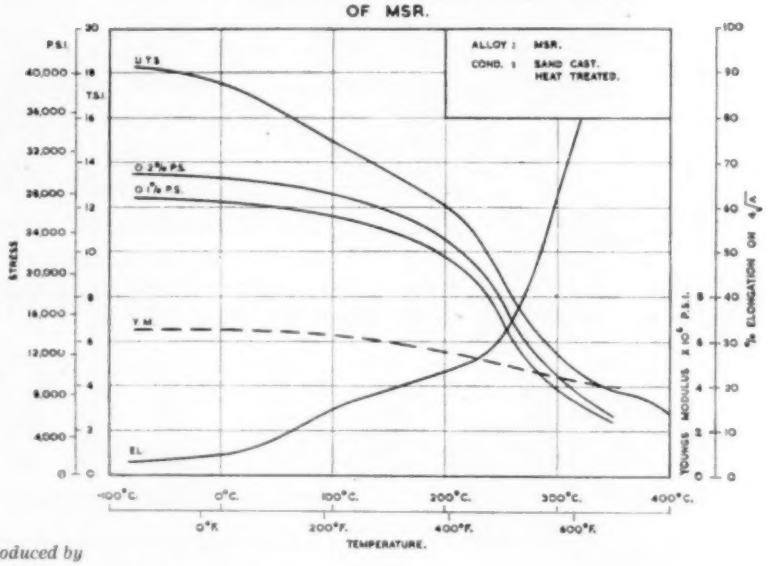

MSR

High strength casting alloy

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Produced by

Magnesium Elektron Limited

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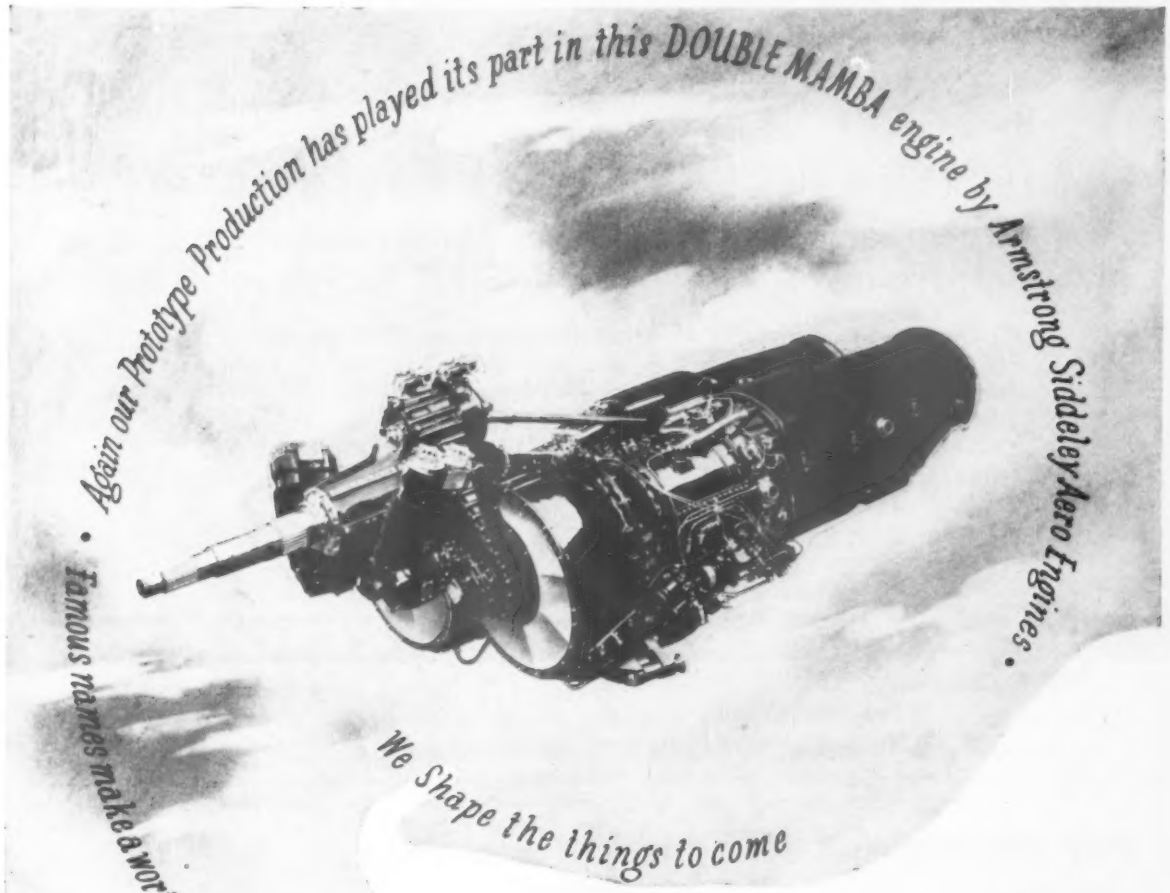
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- Weight Control Engineers.

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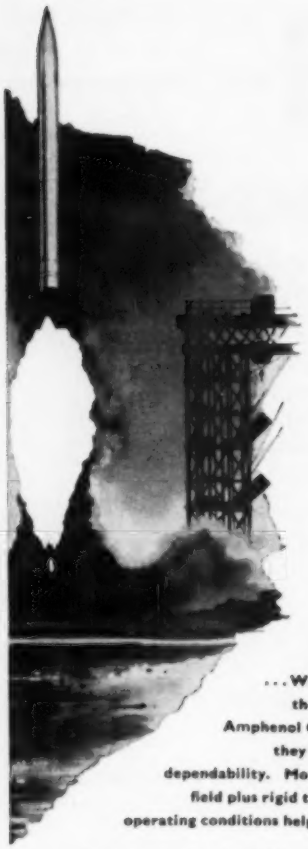
- Electrical installations.
- Engine equipment and control installations.
- Structural Design and engine installation.
- Power controls.
- Mechanical design, e.g., undercarriage design, control boxes, escape facilities.
- Flight test instrumentation.

If you are interested in one of these subjects and would like to make an appointment to discuss these opportunities on an informal basis, we invite you to write in confidence to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting reference A/1716C; giving details of your qualifications and experience and indicating your particular interest.

Appointments will be arranged by the Aircraft Division to suit your convenience, and we will endeavour to meet you at a centre within easy access to your home.

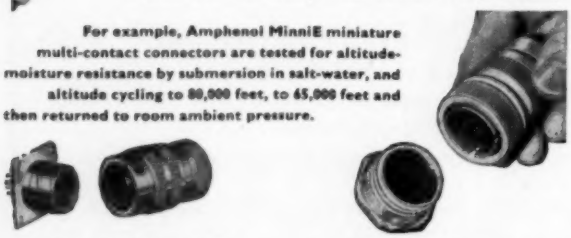
All appointments will be permanent and pensionable, after a qualifying period, and assistance with removals and housing will be given in certain cases.



WHEN THERE CAN BE NO COMPROMISE WITH RELIABILITY . . .

. . . When maximum performance under the most exacting conditions is vital, Amphenol Connectors play the part for which they have been designed with complete dependability. More than 25 years' experience in this field plus rigid test requirements far beyond likely operating conditions help to ensure their sturdy reliability.

For example, Amphenol MinniE miniature multi-contact connectors are tested for altitude-moisture resistance by submersion in salt-water, and altitude cycling to 80,000 feet, to 65,000 feet and then returned to room ambient pressure.



Amphenol "MinniE" Connector

Quick disconnect, multi-contact, miniature bayonet lock types. Available as Plugs, Cable and Panel Receptacles and Single Hole mounting Receptacles in four constructions, five shell sizes and seventeen insert arrangements.

Amphenol "165 Series" Connector

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Input current, milliamps	20	52
Input power, watts	.15	.34
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DC resistance rotor, ohms	200	14
DC resistance stator, ohms	130	76
Phase shift degrees	7°	10°
Residual voltage total, millivolts	58	27
Residual voltage fundamental, millivolts	38	17
Electrical Error, minutes	7 max.	7 max.

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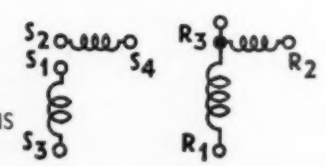

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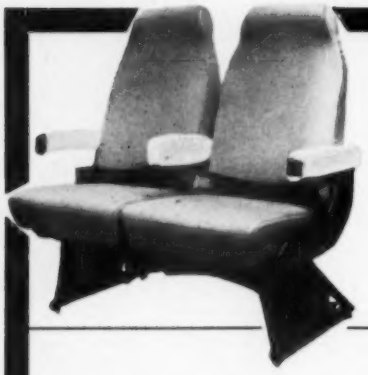

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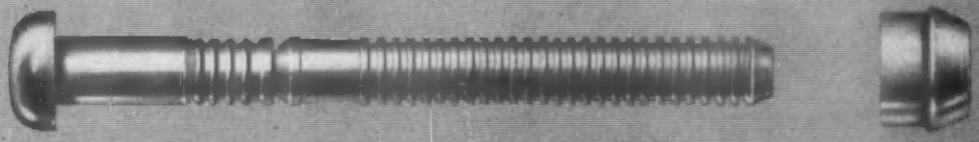

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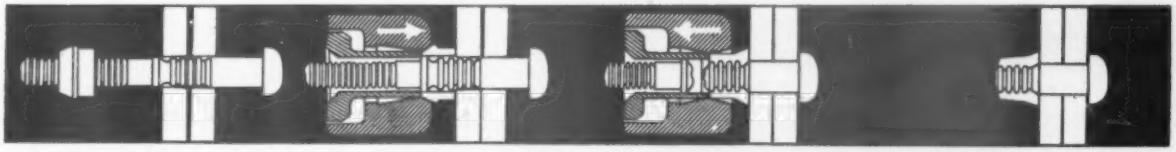

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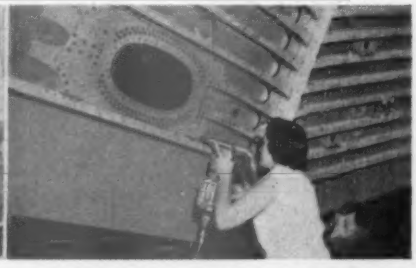

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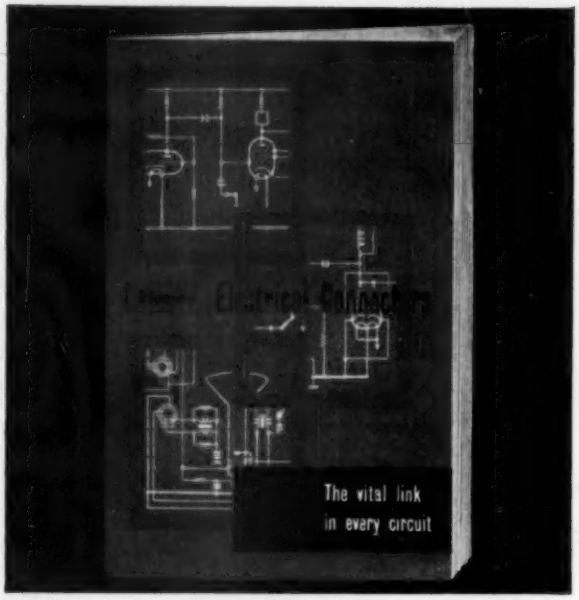

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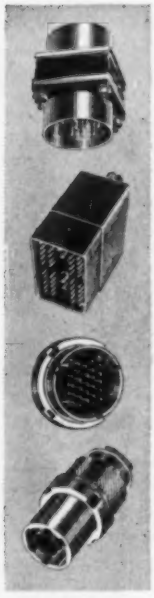

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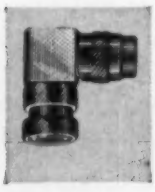

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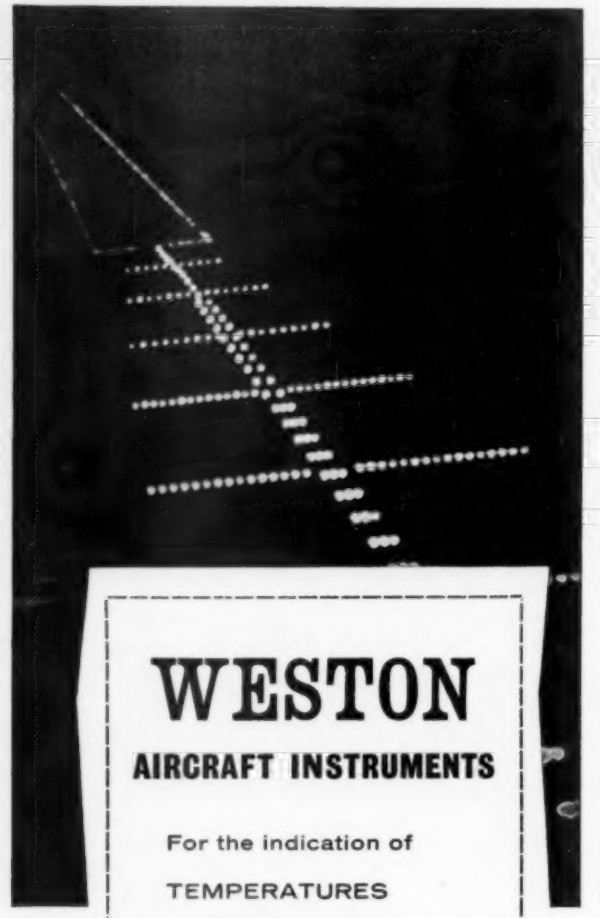

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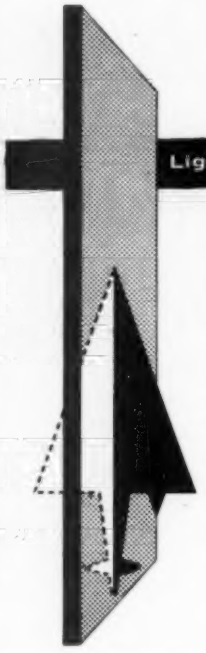

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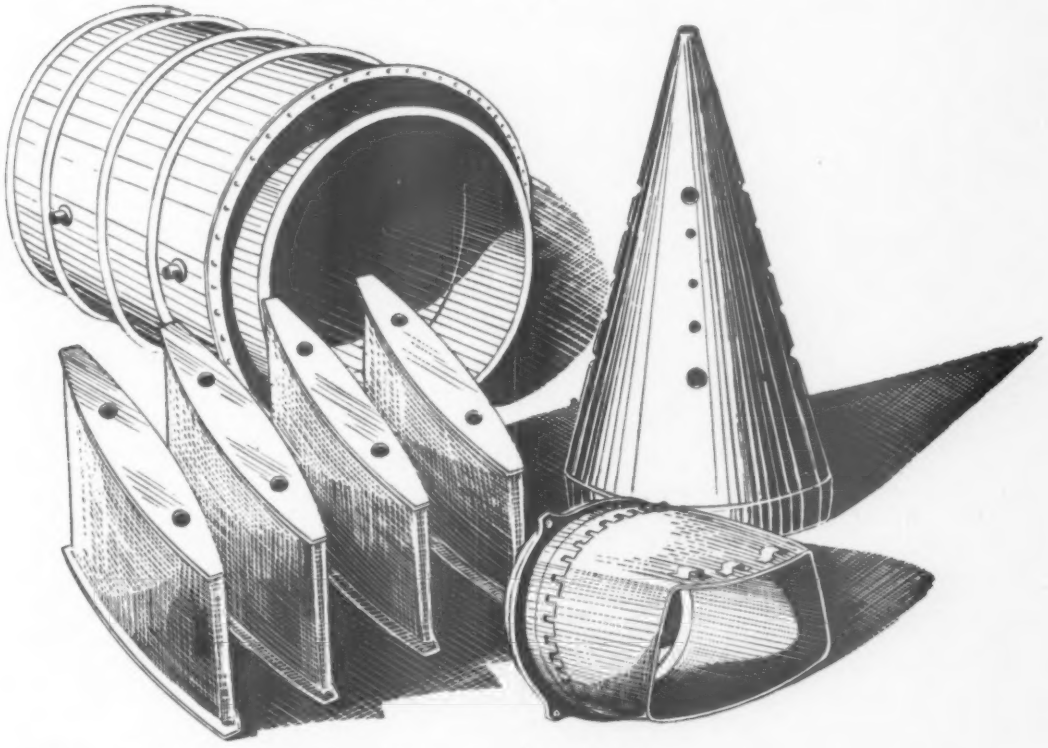

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THE AEROPLANE and ASTRONAUTICS

VOLUME 98 NUMBER 2524 MARCH 4, 1960

Air Safety—A Call to Arms

There could be no doubt in the minds of those who attended the annual livery dinner of the Guild of Air Pilots and Air Navigators at Grocers' Hall on Feb. 23 that this youngest of the City Livery Companies has really arrived. When the Master, Dr. K. G. Bergin, in his gorgeous robes, appeared with the Lord Mayor in the procession to the top table accompanied by the beadle, beruffled and splendid in a new gown, it was the opening of what turned out to be an outstanding occasion. Members of the Guild had been looking forward to congratulating the Grand Master on the birth of the second Prince. In his absence because of Royal Family mourning they proffered their condolences on the death of his aunt, the Countess Mountbatten.

Most notable event of the evening was the swingeing attack by Lord Brabazon on behalf of Air Safety. Its timeliness was emphasized by the disasters which have occurred since by collision in the air and by accident during take-off at high speed. It was that great writer, the founder editor of THE AEROPLANE, who coined the phrase that "aeroplanes should land slowly and not burn up." Today both these characteristics are technically available. Lord Brabazon made it clear that if the wind of change is to blow in aviation, concerted action must begin now. The Guild of Air Pilots and Air Navigators have announced their concern with Air Safety. There can be no doubt there is plenty to do. Let them follow Lord Brabazon's lead.

Schlösser in Spain

Western Germany's search for military facilities, including air bases, in Spain, which has aroused widespread misgivings, becomes easier to understand when related to the circumstances mentioned in our issue of Aug. 21, last year. In "The Lagging Luftwaffe," we related the difficulties encountered in obtaining enough airfields for the West German Air Arm, particularly through the opposition of the Länder, or provincial authorities, who are reluctant to part with the necessary land.

From the political point of view, the German approach appeared almost unbelievably clumsy, and has caused doubts to be raised on many aspects of the rearmament programme. The Federal German necessity for nearly 700 F-104G Starfighters is being questioned, as is the need for an overall Luftwaffe strength of more than 2,000 aircraft.

In the meantime, Western German air strength continues to build up slowly. Present strength comprises 10 operational Geschwader, supported by two transport Geschwader. These comprise five fighter-bomber units, with F-84Fs: Nr. 31, at Nörvenich; Nr. 32, Lechfeld, Nr. 33, Bücheln/Eifel; Nr. 34, Memmingen; and Nr. 35, Husum. Three day-fighter Geschwader, also with 36 aircraft (Sabre 6s) each, comprise: Nr. 71, Ahlhorn; Nr. 72, Leck; and Nr. 73, Oldenburg; while two tactical reconnaissance squadrons, with a similar establishment of RF-84Fs, are Nr. 51 and Nr. 52 at Erding. These are due to move to Manching and Eggebeck, respectively. The transport units, with C-47s and Noratlas, comprise Nr. 61 and 62 Geschwader at Neubiberg and Celle.

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Matters of Moment

British Aircraft Corporation

AS forecast in our issue last week, the major airframe and missile holding company owned jointly by the English Electric Co., Ltd. (40%), Vickers, Ltd. (40%) and the Bristol Aeroplane Co., Ltd. (20%), has been registered as the British Aircraft Corporation, Ltd. Its wholly owned subsidiaries are English Electric Aviation, Ltd., Vickers-Armstrongs (Aircraft), Ltd., and Bristol Aircraft, Ltd. (less its helicopter interests which have been sold to Westland Aircraft, Ltd.).

Details of the company's board and the way it will operate have not yet been given. But with its registration the names are now known of the five industrial groups which are the "chosen instruments" to qualify for first call on Government support. They are Hawker Siddeley Aviation, Ltd., the British Aircraft Corporation, Ltd., Bristol Siddeley Engines, Ltd., Rolls-Royce, Ltd., and Westland Aircraft, Ltd.

Changes in the Westland Board

FOLLOWING the acquisition, last year, of the Saunders-Roe company by Westland Aircraft, Ltd., it was announced that Capt. E. C. Clarke, C.B.E., M.C., managing director of the former company, would retain that position and also become a member of the Westland board. News has now come of his withdrawal from these two appointments with effect from March 1. Mr. H. W. D. Winkworth, M.I.Prod.E., has been appointed by Westland Aircraft to the new post of director in charge, Saunders-Roe, Ltd.

Captain Clarke had been with Saunders-Roe since March, 1937, when he joined the company as commercial director. In November, 1939, he became joint managing director with the late H. E. Broadsmith, F.R.Ae.S., M.I.N.A., M.I.Mech.E., and was appointed managing director in July, 1945, when Mr. Broadsmith retired.

Mr. Winkworth has been works director of Saunders-Roe since December, 1958; he joined the company in 1946 as production engineer and became assistant general manager in 1957. Born in 1913, he served his apprenticeship with Short Bros.

Joining the H.S. Board

WITH the merger of de Havilland Holdings and the Blackburn Group with the Hawker Siddeley Group, certain board changes were planned. These have now been implemented and last week Sir Roy Dobson announced five new appointments to the Hawker Siddeley Group board. Sir Aubrey Burke, O.B.E., M.Inst.T., F.R.S.A., chairman of de Havilland Holdings, becomes deputy managing director of the H.S. Group. Mr. J. A. R. Kay, F.R.Ae.S., and Mr. J. T. Lidbury, joint managing directors of Hawker Siddeley Aviation, are now directors of the parent Group. Mr. A. Jopling, F.C.A., chairman of the Blackburn Group, and Mr. A. S. Kennedy, C.A., a member of the board of de Havilland Holdings, have also joined the H.S. Group board.

The board of the Hawker Siddeley Group is now 13 strong. With these five new members it now comprises:—

Sir Thomas Sopwith (chairman); Sir Roy Dobson (vice-chairman and managing director), Sir Aubrey Burke (deputy managing director), Mr. Hugh Burroughes, Mr. H. T. Chapman, Mr. J. F. Robertson (financial director), Sir Arnold Hall, Mr. H. G. Herrington, Sir Halford Reddish, Mr. J. A. R. Kay, Mr. J. T. Lidbury, Mr. Arthur Jopling and Mr. A. S. Kennedy.

Sir Aubrey Burke, who received his knighthood in the 1959 New Year Honours, started his aeronautical career with Vickers, Ltd., on airships. He joined Airwork, Ltd., at Heston, in 1933 and two years later went to Imperial Airways. When B.O.A.C. was formed in 1939 he became its superintendent of technical development. During the War he was with the Ministry of Aircraft Production, but rejoined B.O.A.C. in 1943 as assistant director-general (technical).

Sir Aubrey's association with de Havillands started in 1944 when he joined the Engine Company as director and general manager; he became its managing director in 1948 and its chairman in 1955. Appointed to the board of de Havilland Holdings in 1955 and managing director of de Havilland Aircraft in 1956, he subsequently became chairman of de Havilland Holdings, and of the D.H. Aircraft and Propeller companies. He has been a member of the Air Registration Board since 1956; a member of the Council of the S.B.A.C. since 1946 and its president for 1958/60.

POMP AND CEREMONY.—At this year's annual banquet of G.A.P.A.N. at Grocers' Hall, the reply to the toast of the Guild, in the absence of the Grand Master, the Prince Philip, owing to Royal Family mourning, was given by the Master, Dr. K. G Bergin (upper picture). The Lord Mayor of the City of London, Sir Edmund Stockdale, is seen handing the Cumberbatch Trophy to Mr. James Martin.

SWIFTER SORTIES.—During their first two months of "Swifter" trials, the six modified Canberras of the Joint R.A.F.—M.o.A. unit at El Adem (Sqn. Ldr. P. A. Thompson (front left)) logged 133 sorties.

More Dollars for Rolls-Royce

WITH the confirmation last week of United Air Lines' order for 20 Caravelles came the welcome news that these aircraft will be Avon-engined. The value of the engine order to Rolls-Royce is £3.3 million ($9.24 million). It is the first ever placed by a U.S. domestic airline for non-American turbojet engines.

The Caravelles are to be built in France by Sud-Aviation, for delivery between the spring of 1961 and January, 1962. Any Caravelles which Douglas may build eventually, following last month's agreement between the U.S. manufacturer and Sud-Aviation, could not be available as soon as this; nor could a version with General Electric CJ805-23 turbofans, which is being developed. The version ordered by United is known as the Caravelle 6RU, and the Avons are of 531R type, with a guaranteed thrust of 12,080 lb. and fitted with thrust reversers.

Rolls-Royce has now sold its turbine engines to 14 U.S. operators (11 use Darts and two have ordered Tynes). Caravelle sales now total 81 to 10 airlines. All Caravelles ordered so far have Avon engines, but United is the first to specify reverse thrust.

English Electric News

PROGRESS with the Lightning fighter and the Thunderbird surface-to-air missile was referred to by Lord Nelson of Stafford, the chairman of English Electric, in his report on the company's activities during 1959. The development batch of Lightnings was completed during 1959 and production aircraft are now flying; the aircraft will enter R.A.F. service in 1960. Orders have been received for several later marks of the Lightning.

Development of Thunderbird's successor is going well. Making use of the most advanced radar techniques, it retains Thunderbird's mobility and reliability but has a greater range and better performance against low-flying aircraft. The survey of English Electric activities also mentioned the company's Blue Water medium-range mobile ground-to-ground missile which has been designed to replace conventional corps artillery.

Lord Nelson also spoke of the decision by English Electric, Bristol and Vickers to amalgamate their aircraft and guided weapons' companies. English Electric will own a 40% interest in this company, which will take over the share capital of English Electric Aviation, Ltd.

Orders for the Canberra and for the production of current marks of Lightning and the Thunderbird will continue to be for the account of the English Electric Co., Ltd. Later marks of Lightning and Thunderbird and all other aircraft and missiles will be related to the new joint company. But the English Electric Co., Ltd., will continue to manufacture aircraft as a sub-contractor to this new holding company.

Discussing D. Napier and Son, which is a wholly owned subsidiary of English Electric, Lord Nelson referred to the company's 1959 trading loss of £1,200,000. This was mainly due to excessive manufacturing costs in the initial production of two new aero-engines (presumably the Eland and Gazelle). Measures have been taken to rectify the Napier position and a substantial improvement is expected in 1960.

Perfect Gliding Scholarships

FROM the Air League of the British Empire has come information about the 1960 Robert Perfect Flying Scholarship. Last year, it will be remembered, one such scholarship was awarded; this year it is intended to vary the award and to make provision for a total of six scholars. These will each be given a 14-day flying training course at selected gliding clubs.

These awards will be made to the authors of the six best essays received on a chosen subject. This is: "One of the objects for which the Air League was founded in 1909 was to disseminate knowledge and spread information showing the vital importance to the British Empire of aerial supremacy, upon which its commerce, communications, defence and its very existence must largely depend." Scholarship candidates have to show why this object is as important today as it was in 1909; 3,000 words are regarded as the "optimum."

Any British subject under the age of 21 on March 31, 1960, is eligible provided he or she is medically fit and has attained the minimum age to fly solo in a glider (this is 16). Holders, or past holders of civil pilots licences; qualified Service pilots; and holders of "C" (or more advanced) gliding certificates, are not eligible.

Further details of the scholarship essay competition can be obtained from the Secretary-General of the Air League at Londonderry House, 19 Park Lane, London, W.1.

Planning for Helicopter Services

BRITISH EUROPEAN AIRWAYS has been guaranteed a sum of £1,400,000 by the Ministry of Aviation as a contribution towards the introduction of the Fairey Rotodyne into service. A £4 million development contract for the Rotodyne having also been placed with the Westland group, the way is presumably now clear for B.E.A. to confirm an initial order for six of these aircraft.

In a short debate in the House on the subject of helicopter passenger services, the Parliamentary Secretary to the M.o.A. said that B.E.A. still has not decided which interim type of helicopter it may wish to purchase. In addition to the Vertol 107 and the Sikorsky S-61, Mr. Rippon mentioned the more powerful British version of the S-61 (the Wiltshire), the civil Bristol 192C, expected to be available in 1962-64, and "a possibility of a Bristol 194."

Referring to the applications which have been made to the A.T.A.C. by B.E.A. and independent operators for domestic and international services, Mr. Rippon said that the Ministry

LATIN-AMERICAN FRIENDS.—Members of the Peruvian President's entourage visited the Central Flying School at Little Rissington last week. General F. A. P. Enrique Ciriani (second from left) head of the President's Military Household, is watching a demonstration. With his back to the camera is Air Marshal Sir Hugh A. Constantine, A.O.C.-in-C. Flying Training Command. Extreme left is the Commandant, C.F.S., Air Cdre. J. N. H. Whitworth. Extreme right, Capt. Alfonso Navarro, Peruvian Naval Attaché in Paris. Left, Jet Provosts in formation; below left, the Westland Wasp and Wessex.

Matters of Moment . . . .

had no intention "to allow the various interests to stake out claims in advance before there is any real prospect of the commercial operation of these routes."

The committee, appointed last July to consider possible sites and facilities for heliports in the London area, hopes to present an interim report fairly soon. Charing Cross station is among the sites considered. The M.o.A. has also given advice about heliports to more than 100 local authorities.

Lord Douglas, chairman of B.E.A., also had something to say about helicopters recently, following a series of visits to American manufacturers. He described the "first practical multi-engine transport helicopters" which are now flying as being "the equivalent stage in the evolution of the helicopter to that represented by the 21-passenger DC-3 in fixed-wing development when it first appeared in the mid-1930s."

B.E.A., said Lord Douglas, would have to order "quite soon" a small number of helicopters, but the question of how the operations are to be financed still had to be resolved.

It is worth recalling, in the context of these official pronouncements, recent remarks of Mr. Robert L. Cummings, Jr., president of New York Airways. He said (see our issue for February 12, p. 182) that, with the new helicopters becoming available next year, "commercial revenues could, for the first time, offset all operating charges and produce a fair return on the capital investment—without Government financial support." With Vertol 107s, New York Airways expects to be operating free of subsidy by 1966.

"The Wind of Change is Long Overdue"

STRONG views about dangerous aspects of civil aviation were voiced by Lord Brabazon of Tara, P.C., G.B.E., M.C., Hon. F.R.Ae.S., chairman of the Air Registration Board, at the annual livery dinner of the Guild of Air Pilots and Air Navigators in London on Feb. 23. Here, verbatim, is most of what he had to say on this vitally important subject:—

"What is so marvellous to me is the concentrated development that has taken place in so short a time really, 50 years. You would expect that as aeroplanes developed it would become easier and easier to pilot the machines, but that is not so; it has become more and more difficult. Every new machine we see introduces new hazards for the pilot.

"The ratio of speed to stall is still lamentable. We have got to the stage now when we have to run along the ground two miles before we get off. We have got to the stage where we touch-down at the dawdling speed of 150 knots. Nobody is going to persuade me that that is basically safe.

"There are only two things that come out on the safety side of flight today. One of them is a curious one. Piston engines are notoriously at their worst from a point of view of reliability on boost on take-off, whereas the jet engine is at its best when cool and taking off.

"The other thing is the use of paraffin instead of petrol. I am not talking about the fashionable crash when a pilot steers his aeroplane straight into a hill. If that happens, of course, it is too bad for everybody. But accidents do occur on the aerodrome, through swerving, through bad landing and that sort of thing. If you have paraffin instead of petrol, you do have a chance of getting out, you have four or five minutes in which you can escape. I notice a tendency with some operators to use petrol with jet engines.

"Now I do say, and I hope my voice will be heard all round the World, that if there is an accident of that sort and if an operator has been using petrol instead of paraffin then he should be had up undoubtedly for manslaughter. It is inexcusable to do a thing like that.

"I think it is odd that in this year we have not got a non-inflammable hydraulic fluid. I think that it is rather odd that though we do not know the forces in a thunderstorm we allow pilots to go through them. We know so little about thunderstorms, but quite moderate thunderstorms have forces inside them quite able to tear your wing off.

"I think it very odd that an aeroplane costing well over a million pounds (sterling) should be widely sold throughout the World and accepted by operators when with one engine out a pressure of 160 lb. is required on the pedal just to keep it straight.

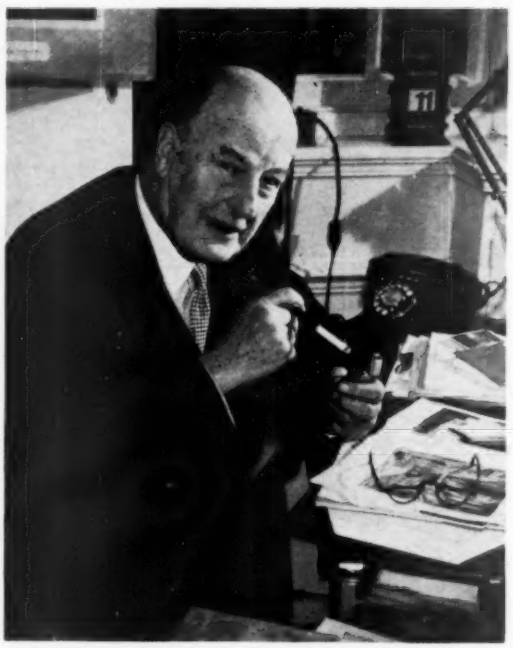
* * *

"I say with fervid truth this: there are many of you here today, pilots round this table, who will be alive two years hence entirely due to what Davies (the A.R.B. test pilot) did at Seattle the other day.

* * *

"The wind of change is long overdue in aeronautics and I believe it is coming. Wing-loading and take-off and landing speeds have all steadily increased. If this goes on, even greater demands are going to be made on the pilot.

"Various governments are prepared to produce longer and longer runways; if that is so you can hardly expect the designer to keep out of the race for pure speed. I had hoped that one day on an international basis there would be a limit put to this trend and a definite length of runway determined. If we are to have a transport machine flying at Mach 3, in the 1970s, let us try and lay down the rule that it shall have vertical take-off and landing. But if we don't insist on some of these things we shall have the standard runway for that type of machine rivalling M1 in length.



"Most sincere friend and devoted servant."

"I think the theory must go that the pilot is an automaton to be put in any machine the operator or designer likes—that should be resisted. We must remember that, in spite of all our regulations in the Air Registration Board, in spite of all your Ministry of Aviation regulations, in the end the ultimate safety of the passengers lies with the pilot.

"The modern pilot, as he sits in the great liner of today, about to take-off, doing his cockpit drill, which may take up half an hour, has to understand a complexity of dials that would put a first-class computer to shame, the while he has to operate what looks like a five-manual organ complete with stops. He has got to drive all this at a speed faster than most racing cars until he gets to 'V.2' when he proceeds to what's called 'rotate,' that's a lovely word isn't it—'rotate'—it's a wonder he isn't head over heels by that time.

"It is, I think, a right and proper thing that there should be a great organization like yours to speak with authority on the pilot's side of new machines and that they should also butt in early on the question of design, not at the end but at the beginning. Let not the Guild be afraid, let them speak up. They have many good friends, more than they think, especially round this table.

"I have been an onlooker of aviation now for 52 years, if I have a few years left to continue to be an onlooker of flight, I assure you, you Guild of Air Pilots, if I can ever help, please call upon me, for I am your most sincere friend and devoted servant."

Air Affairs at Westminster

MR. SANDYS has had his biggest week in the House, and it has shown the interest which his appointment has brought in aviation generally among M.P.s. One of the curious things about Mr. Sandys is that he makes news wherever he goes—and yet he never says a word beyond what is strictly necessary.

We have had heliports—they are, legislatively speaking, just around the corner now—rockets—with the deputy Minister hinting at putting a 2,000-lb. satellite into orbit with Blue Streak, Black Knight and a booster rocket—and the hint of a White Paper on Government assistance to the industry.

Taking the last first, Mr. Sandys ran into a great deal of pressure, which was only to be expected, to take shares in aircraft firms and to put directors on their boards in return for Government help. Needless to say, he refused to do either. He has his arrangements, which Lord Mills, in a Lords debate, crystallized thus: "There is no guarantee of success in these types, and therefore the Government are saying—'If this thing proves a seller, and you sell it, we will take a certain percentage of your sales in respect of our help.'"

Mr. Sandys himself is going to wait until his talks with the industry are over before deciding whether to give more information about his financial arrangements with them. He may put it in a White Paper, but at the moment he doubts whether such a publication would be justified.

Just a word on fares—this month should produce a statement from Mr. Sandys on outstanding applications for low fares by the Air Corporations and the Independents.

Space has captured the imagination of Members, and two lively minds were engaged in the short debate the other day. CAPT. CORFIELD (Cons., S. Gloucestershire) is the Member who forced the Government to concede current market values as a basis for land purchase with a private Bill which gained sufficient support for the Government to be compelled to take it seriously. He puts space exploration on to a practical down-to-earth level.

Can we, as an industrial nation, afford not to be part of it? Will we just export skills instead of materials? He thinks the American and Russian programmes must create demands and markets, and we ought to have a share of them. But if we don't—then we cannot expect to retain our best brains indefinitely here.

MR. GEORGE CHETWYND (Lab., Stockton) is another lively fellow whom Mr. Gaitskell had the good sense to make one of his aviation spokesmen recently. Mr. Chetwynd wondered how the Steering Committee is getting on; whether there is a tug-of-war between the scientists and the practical people. He, too, wants Blue Streak to be used for space applications if the Rusisan rocket accuracy has made it out of date as a missile.

MR. GEOFFREY RIPPON, the Under Secretary, gives the appearance of placidity, but is capable of getting excited in the right way. His short speech showed this, and he interested Members very much with his statement that the design studies for adapting military rockets to all-British satellite programmes are well in hand and producing information which is favourable to the project. By the mid-60s, Blue Streak, Black Knight and a booster could put a 1,000-2,000 lb. satellite into orbit 200-300 miles high as a platform for astronomical observation.

The Rotodyne's noise has been reduced since the initial flights, but the Minister said a lot of work has still to be done. But has anyone ever evaluated the noise of a Rotodyne against the background roar of a big city?

People are already applying for licences to run commercial helicopter services, but Mr. Rippon made it clear that no one will be allowed to stake out a claim in advance.

The Minister of Aviation has turned down a proposal for a Royal Corps of Aircraft Designers which, MR. PHILIP NOEL-BAKER suggested, should be on the model of the Royal Corps of Naval Constructors. The latter, says Mr. Sandys, are a body of professional civil servants who design ships only for the Navy, but aircraft for the R.A.F. are designed by the industry itself. "It would be quite impracticable to separate the design of an aircraft for the R.A.F. from the design of civil aircraft."—"PARLIAMENTARIAN."

Hope for the Aerodrome Owners?

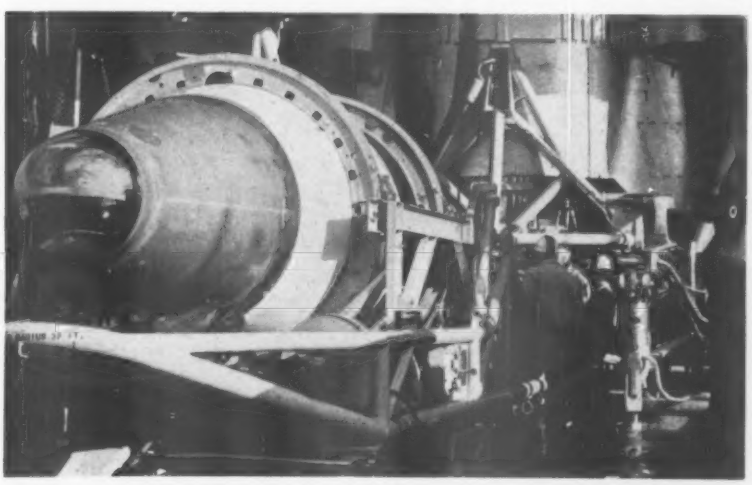
THE hope of some results from the new air transport licensing Bill, coupled with the effects of a non-committal, but not-too-depressing interview—that very afternoon—with the Minister of Aviation, caused the Aerodrome Owners Association speakers at their annual dinner on February 25 to be very slightly more optimistic than usual.

The effect of the Bill might, they thought, encourage more use of municipal and other private aerodromes and Mr. Sandys had, apparently, acknowledged at least an open mind on the subject of possible financial aid. In turn the six speakers, three members and three guests, referred amongst many other things to the need for the new licensing Board to be independent and for natural development to be fostered; to the prospects of the use of many more executive aircraft; to the need for a more helpful attitude in the provision of Customs facilities; to the belief that the Ministry of Aviation was a consulting room rather than a dispensary or surgery; to the fact that all were working towards the same ends; and to the proposition that assistance should at least extend to the supply of essential operating and safety equipment.

Manpowered Flight Activities Multiply

INTEREST in Manpowered Flight shows itself in all sorts of ways, Mr. Peter Masefield, president of the Royal Aeronautical Society, for instance, never misses an opportunity to air the subject in his speeches. It formed the theme of Major Sippé's speech at the 504 Club Dinner.

Now news has reached us of moves in the Midlands to group a number of interested people together to get working on a promising design. The design may, in practice, be all the more promising for incorporating certain features which exclude it from qualifying for the Kremer prize. Finally, a most encouraging statement can be expected in the next week or so about the increasing financial support which is being amassed by MAPAG. It seems that influential people have decided that the new Group of the R.Ae.S. justifies generous support.



MILITARY SATELLITE.—Lockheed's Agena B (Midas) satellite being moved up to the launching pad at Cape Canaveral where the Atlas first stage stands waiting. Midas is designed to detect the launching of ICBMs by infra-red radiation.

RB.163 Details

INTERNAL features of the Rolls-Royce RB.163 by-pass engine have now been revealed. A cutaway drawing included in the Rolls-Royce brochure shows the lay-out of this engine in a podded installation of the type to be used on the Airco D.H.121 transport.

A two-spool engine, the RB.163 has a four-stage L.P. compressor driven by a two-stage L.P. turbine and a 12-stage H.P. compressor driven by a two-stage H.P. turbine. In the podded installation it has a thrust reverser and a fluted silencing nozzle. Low maintenance and overhaul costs are claimed as special characteristics of this new by-pass engine.

The engine has a by-pass ratio of 1.0, a mass-flow of 202 lb./sec., a pressure ratio of 16 : 1 and a maximum basic dry weight of 2,315 lb. Take-off thrust is 9,850 lb., at an s.f.c. of 0.578 lb./lb./hr., and maximum continuous thrust is 9,450 lb., at an s.f.c of 0.570 lb./lb./hr. Travelling at 25,000 ft. and 525 knots in ISA conditions, typical thrusts and s.f.c.s are 2,200 lb., 0.79; 3,000 lb., 0.78; 4,000 lb., 0.79; 4,400 lb., 0.81.

Aviation News in General

SUPERSONIC LAMINAR-FLOW?—In a B.B.C. radio interview Mr. R. S. Stafford, Handley Page technical director, revealed that his company is advocating laminar-flow techniques to reduce the drag of supersonic airliners. He suggested that, with laminar flow, supersonic operating costs could be less than those of subsonic airliners.

ARGOSY IMPROVED.—Take-off weight of the A.W.650 Argosy has been increased from 82,000 lb. to 88,000 lb. and the maximum payload by 1,000 lb. to 28,000 lb. Flight test data confirm the mean cruising speed as 243 knots, and the max. range with normal reserves as 1,955 naut. miles. Range for lowest direct costs is between 520 and 650 naut. miles.

DARTS ORDERED—Japan Transport Manufacturing Company, which is a consortium of six aircraft manufacturers, has ordered five Rolls-Royce Dart R.Da.10s for use in prototypes of the twin-engined YS-11 transport now under construction.

TEST HOURS.—In flight testing of the Convair 880 up to February 1, 796 aircraft flight hours were logged, and in the course of 3,184 engine flight hours, only three in-flight shut downs were necessary. Of the 534 flights in the programme, none was delayed by engine trouble.

CZECH 'COPTER.—Production has started in Czechoslovakia of the HC-3 helicopter, a five-seater, powered by a 240-b.h.p. M108 H flat-six engine. It is intended for a variety of duties, including training, ambulance work, crop spraying, search and rescue, and as an aerial crane, in addition to transport and communications. Maximum speed is 100 m.p.h., and the gross weight 3,086 lb.

GUARD TRANSPORTS.—The American Air National Guard, corresponding to the former R.Aux.A.F., is converting at least six, and possibly nine, of its air defence and tactical fighter squadrons to the transport rôle. They are being re-equipped with the massive Boeing C-97 Stratocruiser, which will supplement the Fairchild C-123s and Douglas C-124s already in service with the Air Reserve.

LOCKHEED FREIGHTER.—Having failed to obtain U.S.A.F. support for the Allison-powered GL207 Super Hercules, in which both Pan American and Slick had an interest, Lockheed have now proposed a development of the same design with Rolls-Royce Tynes. Intended primarily for the commercial market, the project will be undertaken as a private venture if market research appears favourable.

BELGIAN MAGISTERS.—The first of 45 Potez-Air-Fouga C.M. 170 Magisters for the Belgian Air Force was recently accepted at Toulouse-Blagnac by Gen. Burniaux, its C.A.S., and was airlifted to the training centre at Kamina, in the Belgian Congo. The remaining Magisters are being delivered at the rate of one per week.

DASSAULT DEVELOPMENTS.—The tenth Mirage IIIA recently made its first flight from Melun-Villaroche, and the eighth has achieved M=2.2 in level flight at 54,461 ft. powered by its Atar 9 turbojet and S.E.P.R. rocket. The Avon-powered Etendard IVM-03 ship-board fighter continues its flight tests with blown flaps, giving a take-off run, at max. weight, of less than 400 m. The prototype Mirage IV supersonic bomber research vehicle recently flew at M=1.5 for 20 min.

SKYBOLT B-52.—Two Boeing B-52 bombers are to be used for test-launching of the Douglas GAM-87A Skybolt ALBM. The Wichita Division of Boeing has received a $1.6 million contract for engineering studies, wind-tunnel tests and flight-test planning.

ANTI-MISSILE STUDIES.—A joint Canadian-U.S. programme at Ascension Island in the South Atlantic will evaluate infra-red detection of the re-entry of ballistic-missile nose cones. Canada will contribute CF-100 jet aircraft which have been equipped with photographic and detection systems by the Special Products Division of the de Havilland Aircraft of Canada, Ltd.

MIDAS FAILS.—First test firing of a Midas ICBM advance-warning satellite failed on February 26 when the second stage of the Atlas-Agena rocket, launched from Cape Canaveral, apparently did not separate. Satellite is designed for the infra-red detection of missiles leaving their launching pads, giving the U.S. up to 30 min. warning.

WOOMERA SPACE - RADAR.—Under a joint agreement between Australia and the United States, the Americans are to erect an 85-ft. radio-telescope at Woomera this summer for the purpose of tracking deep-space probes. Installation will cost £1,600,000.

BOUNCED AGAIN.—Another 100-ft. diameter inflatable test satellite was rocketed from Wallops Island, Virginia, on February 27, this time to a height of 225 miles. Using the sphere as a passive reflector, intelligible speech messages were successfully transmitted between two U.S. radio stations.

TITAN TRIUMPH.—A Martin Titan ICBM, fired from Cape Canaveral on February 24, deposited its nose-cone in a target area near Ascension Island, some 5,000 miles from the launching point.

EAST GERMAN ORDER.—English Electric has received a £50,000 order from East Germany; it covers constant-frequency A.C. power-supply equipment for the BB-155 twin-engined jet transport now under development. In addition, it has a letter of intent for equipment worth £130,000.

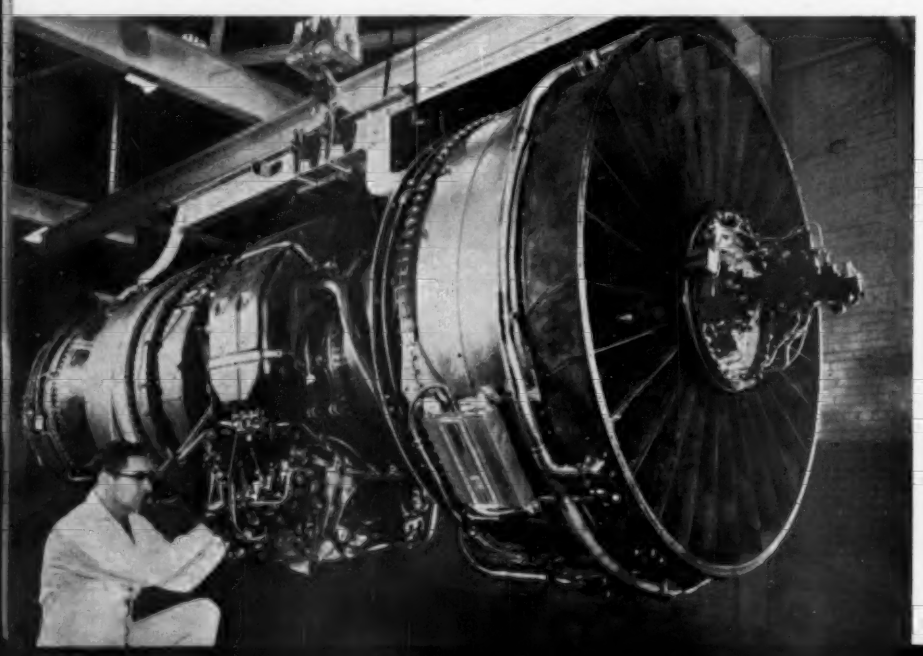
D.H. CANADA CHANGE.—The de Havilland Aircraft of Canada, Ltd., has renamed its Guided Missiles Division; it is now known as the Special Products Division.

HUNTING - CLAN IN GENEVA.—Mr. H. St. George Bond has been appointed special representative for Hunting-Clan Air Transport and Field Aircraft Services in Geneva. He will be particularly concerned with business with the six Common Market countries, Switzerland and Austria.

A VICKERS PROMOTION.—Mr. A. H. C. Greenwood, A.F.R.Ae.S., A.F.C.A.I., M.I.A.S., has been appointed an additional director of Vickers-Armstrongs (Aircraft), Ltd. with effect from February 25. He has been deputy general manager at Weybridge since 1958 and a special director of the company since 1955.

ELLIOTT SALES.—Mr. J. A. Benn has joined the Aircraft Engine Instruments Division of Elliott Brothers (London), Ltd., as technical liaison officer.

SPECIALIZED SERVICE.—A new public relations agency, Bailey-Watson and Associates, has opened at 7 Rembrandt Close, London, S.W.1. Headed by Mr. C. B. Bailey-Watson, who was formerly public relations manager of The Bristol Aeroplane Co., the agency is offering specialized services for specialist industries.



B-52 TURBOFAN.—Boeing has received its initial shipment of Pratt & Whitney TF33 turbofans for the B-52H bomber. In its civil form this engine is known as the JT3D.

Air Transport

Proving and Improving the Vanguard

THE battle to maintain and to develop the turboprop transports' position as vital airline operating equipment in Europe enters its second round this year. The Viscount won the first round against the piston-engined fleets; B.E.A.'s Vanguards and K.L.M.'s Electras will now fight the second round against much stiffer opposition—this time from the turbojets.

In fact, because unilateral fare reductions are not possible, the battle will be fought in the airlines' traffic and sales offices. It can be shown that the Vanguard is very nearly as fast as—and sometimes faster than—the turbojet over short sectors and its economics make good sense so long as it is allowed to carry a reasonable proportion of the traffic. Over short-medium sectors, therefore, success depends on encouraging the travelling public to be objective about such relatively marginal matters as noise and vibration levels, whilst making the most of scheduling regularity and normal creature comforts.

The first B.E.A. Vanguard service will be flown on July 1 from London to Paris, and just now the fifth production aircraft (G-APED), which is the fourth for the Corporation, is undergoing a rigorous proving programme. During this programme 200 hours are being flown on typical European routes to typical schedules and with normal turn-rounds.

The first series of services were between London and Paris and Brussels. This week the runs have been extended to points such as Rome and Lisbon. At least two full-passenger-load long-haul flights will be included in order to provide a practical check of the air-conditioning and pressurization, and of domestic passenger systems and general catering arrangements with B.E.A. cabin crews. Corporation captains are handling the trials with Vickers pilots and technicians and other representatives on board. A trio of three-pilot crews, plus one extra pilot, 10 in all, are flying the aircraft in rotation.

This Vanguard is laid out as a 100-seater, with 63 seats in six-abreast rows in the central compartment, 17 five-abreast first-class seats in the rear compartment and 20 five-abreast seats in the forward compartment. Our own experience on two of the proving flights showed that, so far as noise level and vibration are concerned, there is little to choose between the three compartments, but the aft area is slightly superior and is conveniently placed for class-segregation purposes. Passengers enter and leave by forward and rear doors, both of which have built-in air-stairs for quick turn-rounds.

There is nowhere in the aeroplane any sensation for a passenger of being packed in a tube; the two "domestic" areas break down the length of the fuselage and the furnishing and lighting are such as to give the cabins a pleasant "square-section" look. Even with six-abreast seating there is ample elbow room and the aisle is very reasonably wide. Freedom of movement was adequately demonstrated during the proving flights, on which technicians and others were necessarily liable to wander about very freely. Variations in seating to accommodate up to 139 passengers is simplified by the use of movable passenger-service panels, with individual lights, air ducts and call-buttons, which are mounted underneath the wide overhead shelf.

Important new figures for the Vanguard were issued last week-end. In short, the new figures mean that the V950 Mk. 2, for delivery in 1961, will have the payload increased by 8,000 lb. to 37,000 lb.—permitting a full-passenger (139) payload with underfloor freight increased to 8,000 lb. The maximum landing and zero-fuel weights have been raised by 9,500 lb. and 10,000 lb. respectively (to 130,500 lb. and 122,500 lb.) so that the Mk. 2 Vanguard will be able to fly two or three sectors without intermediate refuelling.

VANGUARDS IN QUANTITY.—While the first few Vanguards for B.E.A. are being used for intensive flight trials and crew familiarization, the production line at Weybridge is concerned also with 20 Vanguards for T.C.A. Significant improvements in the Vanguard's economy are reported above.

Photograph copyright "The Aeroplane and Astronautics"

The IATA Fares Conferences

WHEN this issue appears the revived IATA fares conferences will only have been in progress in Paris for about nine working days. They were expected to last for at least a fortnight and probably for three weeks.

At the end of the first four days it was announced that North Atlantic carriers had agreed to continue to apply the 1959-60 fares until May 1 and to carry on with the turbojet surcharge until that date. The present fare agreements would normally have ceased to be applicable after March 31 and the surcharge had been agreed as being applicable only until March 1. Evidently the surcharge is being maintained in order to keep the talks free so far as differentials are concerned. Since the negotiations are closed to all outsiders, nothing more is likely to be known until the conferences have actually ended—successfully or otherwise.

It might, however, be useful at this stage to outline some of the main causes of the breakdown in Honolulu last autumn. The basis of the disagreement appears to have been mainly in B.O.A.C.'s inflexible insistence, rightly or wrongly, on the introduction of economy fares at certain minimum percentages of present tourist fares on routes through Africa, and through Asia to Australasia—with Africa as the crucial area. Although other delegates also went to the conferences with little or no power to negotiate, the Corporation appears to have been one of those who were the least ready for compromise.

The conferences had started inauspiciously in that, at a preliminary New York meeting of North Atlantic carriers, only B.O.A.C. had insisted on the retention of three fare classes and on the first day at Honolulu all but the Corporation

Air Transport . . . .

favoured a World-wide two-tier fare structure. This disagreement must obviously have affected the overall discussions.

Compromise suggestions for dealing with the African deadlock—which appears to have prevented the prospect of compromises in other areas—were not successful. One of these was to the effect that promotional fares should be agreed for 1960, with economy fares (to be settled by the IATA Cost Committee in relation to turbojet operations) for 1961; this was acceptable to all but four airlines.

Agreement on seat pitch and other interior arrangements, and on the offer of sleeping berths, appears to have been equally impossible. No decision was reached, either, about the difficult question of downward differentials for propeller-driven aircraft when these were being operated alongside turbojets.

The B.O.A.C. team in Paris consists of eight representatives, led by Mr. Gilbert Lee, commercial director. A three-man B.E.A. team is led by Mr. P. C. F. Lawton, commercial and sales director. The unresolved fare patterns are those for services over the North and mid-Atlantic, from Europe through Africa, to the Far East and Australasia, within Australasia and across the Pacific. In IATA terminology these cover the whole of Conference Areas 1 and 3, and the African sections of Area 2. Mr. V. H. L. Dubourcq, of K.L.M., is chairman of the conferences.

South American Air Union

A FEW more details became known last week of the plans being made for a joint air operating company to be formed by the Governments of Chile, Colombia, Ecuador, Panama and Peru. Venezuela may also participate in the scheme, which involves the setting up of a new supra-national operating company to be known, according to reports, as Flota Aérea Latinoamericana (FALA), to take the place of the national airlines of each of the countries concerned. The plan appears to envisage an arrangement similar to that which led to the creation of S.A.S. by Sweden, Denmark and Norway, rather than the European Air Union which, to start with at least, does not involve such a complete merging of interests.

More talks about FALA are to take place in Santiago this month. It is suggested that each of the participating countries will hold equal shares in the new company, and each will contribute a like sum to provide FALA with its initial working capital. The fleets, equipment and personnel of the national airlines would, presumably, be absorbed, but FALA would also seek new jet equipment as an early priority. None of the national airlines has any aircraft more up to date than the Fairchild F-27 in service or on order.

Of the five nations most immediately involved in the plans for FALA, Colombia has the largest airline and is the only one flying to Europe. This is Avianca, which flies services to Lisbon, Madrid, Paris and Frankfurt, and also operates into the U.S. and within South America. It is partly nationalized, has a Pan American affiliation and is a descendent of SCADTA, founded in 1919. Next most important is LAN-Chile, a national airline operating domestic and international services almost wholly within South America.

Ecuador's Cia Ecuatoriana de Aviacion operates to Miami and to Santiago with a DC-6. Panama's international operator is Aerovias Panama Airways, with a fleet of DC-4s operating to Kingston, Havana, Miami and Lima. Largest of the three Peruvian airlines is Faucett, operating services within South America with DC-4s and DC-3s.

It is clear from these details that the formation of FALA is seen as a means of creating an airline strong enough to meet the growing competition from foreign operators—competition which individually none of these countries can do much about.

The Brazilian Accident

THE collision near Rio de Janeiro on February 25 between a Real Aerovias DC-3 and a U.S. Navy DC-6 highlights the vital importance of improvement in air traffic control systems and methods. The U.S. aircraft was carrying 38, of whom three survived; the DC-3 carried 24 passengers and a crew of four. The collision apparently occurred in cloud at about 6,000 ft. and the two aircraft fell into Rio Bay.

The DC-6, according to reports, was on its approach to the international airport of Galeao, while the Real aircraft was coming in to land at the city's local-service Santos Dumont airport. Consequently it would not be reasonable to compare this collision directly with that which occurred last December between a Viscount and a military trainer.

Nevertheless, it might be pertinent to quote from the 1959 annual report of the International Federation of Airline Pilots Associations in which the Federation's executive secretary referred to the air traffic control situation at Rio as having "deteriorated" since the previous year's report.

Commercial Aviation Affairs

TORONTO COMET. — B.O.A.C. inaugurated a London-Toronto service on March 1, with Comets (two a week) and Britannias (two a week). All services are via Montreal; the Britannias go via Prestwick and, once a week, via Manchester also. The pooling agreement between B.O.A.C. and T.C.A. came into effect on the same date.

ANOTHER ELECTRA. — Permission for T.A.A. to purchase a third Lockheed Electra has been given by the Australian Government, which is also to allow Ansett-A.N.A. to charter three Viscounts from T.A.A. in exchange for two DC-6Bs.

AVENSA 880.—Aerovias Venezolanas (Avensa) has ordered a Convair 880M for delivery in March, 1961. The "M" variant has also been ordered by Capital and C.A.T. The Real Aerovias Convair order has been changed from four 880s to three 600s.

PARIS-NORD.—Plans for a new airport to replace Le Bourget by 1967 are being made in Paris. Further expansion at Le Bourget is limited by housing projects around its boundary and a new site is being studied some eight miles farther north of the city centre.

NATIONAL SERVICE. — National Airlines inaugurated service with DC-8s on its New York-Miami route on February 18. It has domestic DC-8Bs with JT-4A engines and 134 seats in mixed first-class/coach configuration. National was the first U.S. domestic operator of Boeing 707s and is now the first to operate both 707s and DC-8s.

NEW SERVICE. — M.o.A. has approved the operation by B.K.S. Air Transport of a normal scheduled service between Southend and Lille.

U.A.L. BASE.—A 300 ft. by 400 ft. maintenance building has been opened by United Air Lines near San Francisco for turbojet overhaul and re-assembly.

PRESTWICK GROWS.—Work on the new control tower for Prestwick was to begin this week, as part of the £3 million redevelopment scheme. Extension of the runway to 9,800 ft. is expected to be complete in June.

VOR-DME ORDERED.—The F.A.A. announced last week that it was placing orders for distance measuring equipment to add to existing VOR stations to provide VOR-DME.

NOVEMBER TRAFFIC.—During November, total traffic carried by U.K. airlines on scheduled services rose by 23.1% over the 1958 figure. Freight ton-miles showed a 26.8% increase and the overall load factor went from 55.2% to 57.5%. Air transport movements at U.K. aerodromes increased by 22%.

A.I.I. TO NEW YORK.—Air India International plans to open its Bombay-London-New York service in May, one month after its Boeing 707s are introduced on the Bombay-London route at a frequency of five services a week.

CZECH IL-18s.—C.S.A. is now conducting proving flights with Il-18s and will introduce them on regular service from April 1, on the routes Prague-Budapest-Beirut-Baghdad and Prague-Zurich-Paris. Domestically, the Il-18 will serve Bratislava and Konice. Two versions are to be used, an all-tourist 80-seater and a mixed-class variant with eight first-class and 70 tourist-class seats.

ACCIDENT CAUSE.—The C.A.B. has "conclusive evidence" that a dynamite explosion occurred in the National Airlines DC-6B which crashed in January, near the seat occupied by Julian Frank, who was insured for nearly $1 million and was facing investigation of various financial deals.

ALITALIA LOSS.—An Alitalia DC-7C crashed immediately after taking off from Prestwick during the night of February 25-26, on a flight from Naples and Rome to New York. Of the 52 occupants, 30 were killed. The accident was the seventh this year to a scheduled airliner and brought to 279 the number of passengers and crew killed.

Only the VANGUARD

paces the jets at much less than half the cost

ALL ROUND Europe, and on record flights in Canada, the Vickers Vanguard has been logging block times which have proved that on short and middle distance routes it can more than hold its own with the jets. It has, in zero wind, beaten current jet schedules on sectors as long as London-Rome (955 st. miles). It has flown London-Gander (2,365 st. miles) in 5 hours 30 minutes, and Toronto-Montreal (335 st. miles) in a record 58 minutes in zero wind.

Other Vanguard block times are:

LONDON-BRUSSELS
230 miles in 45 minutes (5 m.p.h. headwind).

LONDON-HAMBURG
470 miles in 73 minutes—a record (17 m.p.h. tailwind).

LONDON-PARIS
224 miles in 41 minutes (zero wind).

PRESTWICK-KEFLAVIK
920 miles in 2 hours 35 minutes (zero wind).

KEFLAVIK-MONTREAL
2,360 miles in 6 hours 2 minutes (30 m.p.h. headwind).

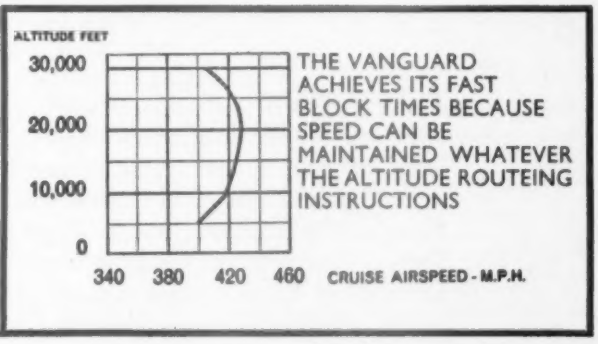
The Vanguard has achieved these block speeds at costs nearly one-third of those of comparable pure jet aircraft.

Recent U.S.A. figures show jet aircraft flight hour direct costs as 2.8 times greater than those of the Vanguard, and seat mile direct costs 2.6 times as great.

The Vickers Vanguard has, without doubt, the biggest profit potential ever offered to the airline industry—and it offers it at proved realistic competitive speeds.

The Economy Class cheap-fare capabilities of the Vanguard are at the forefront of the now established world movement for popular air travel. Only the Vickers Vanguard can bring these vast new markets to the Airlines on short and medium haul routes, at a substantial profit, and the Vanguard can do this with schedules as fast, if not faster, than any other aircraft.

Vanguard costs used in this comparison are to A.T.A. formula. Both the Viscount 745 and the Viscount 810 filed costs have been proved in practice to be substantially below such A.T.A. formula costs.



Of all the airliners only the Vanguard has all these features

425 m.p.h. cruising • Freight capacity 7/8 tons at normal densities • Full routeing and A.T.C. flexibility • Can use normal existing airfields • Quick turn-round • No airfield noise problems • Ten years' unique Vickers/Rolls-Royce turbo-prop experience . . . ***And it is 'Viscount' quiet.***

VICKERS VANGUARD

FOUR ROLLS-ROYCE TYNE TURBO-PROP ENGINES

• ***The airliner with the biggest profit potential ever offered to the operator***

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

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International Welcome for Series 11 "Rotorace" Gyrosyn* Compasses

The SPERRY series "Eleven" Gyrosyn Compasses, incorporating the "Rotorace" directional gyro technique, are now in production in the U.S.A., Canada and the United Kingdom for military and civil operators. Thousands of hours of flying time have already proved the superiority of this new navigational aid in the aircraft of leading civil airline networks and military operators.

* *"Rotorace" and "Gyrosyn" are registered trade marks of Sperry Rand Corporation.*

SPERRY

LONDON · NEW YORK · MONTREAL

SPERRY series "Eleven" Gyrosyn Compasses are in use by, or on order for, many civil airline operators including the following:—

Alitalia—Linee Aeree Italiane
BEA—British European Airways
Canadian Pacific Airlines
Japan Air Lines
K L M—Royal Dutch Airlines
Panagra—Pan American-Grace Airways
Panair do Brasil
Pan American World Airways
SAS—Scandinavian Airlines System
Swissair
T A I—Compagnie de Transports Aériens Intercontinentaux
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U A T—Union Aéromaritime de Transport

In addition, this equipment is being fitted to a large number of military aircraft.

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Air Transport . . . .

CL-44D Developments

Figures for the new long-range, big payload D6 variant and some comments on new criteria for specialist all-freight costing

DURING an appearance at U.S. Civil Aeronautics Board "public convenience and necessity" hearings last month, a Canadair team explained plans for the further development of the CL-44D series of civil freighters. In particular, some detailed information was given about the new CL-44D6 variant.

This is a long-range successor to the medium-range domestic D5 and is designed to carry an approximately similar payload over non-stop ranges in excess of those offered for the D4. It is due for certification by December, 1962, and its outline specification and performance are shown in the accompanying tables and curves where it is compared with the two earlier variants.

The basic CL-44D is a Rolls-Royce Tyne-powered, swing-tail development of the military CL-44 and, as the CL-44D4, has been ordered by Flying Tiger and Seaboard and Western Airlines for delivery in 1961-62. This is essentially a long-range aircraft; in response to expressed requirements for increased payloads over shorter ranges the CL-44D5 has been projected. The design changes involved in this development consist mainly in the strengthening of the wing box and landing gear to allow for a necessary increase of 10,000 lb. in zero-fuel and maximum-landing weights. The gross weight and power are the same as those of the CL-44D4 and certification is planned for December, 1961.

With the prospect of a higher take-off power (maintained with water injection to comparatively high ambient temperatures) from the Stage IV development of the Tyne, it has been possible to consider a higher gross weight. Hence the offer of the CL-44D6, which will be able to carry maximum payloads over transcontinental and transatlantic ranges. Canadair's estimate of direct operating costs for the D6 work out at less than 4 cents/ton-mile when used for U.S. domestic operations.

Costs and Mechanized Loading

During the hearings Canadair pointed out that normal methods of cost analysis were not necessarily applicable to all-freight operations and that the indirect-cost calculations were further complicated by the introduction of mechanical-loading systems and by the lack of analytical methods and research into the factors involved in large-scale all-freight operations.

When applied to bigger and more productive cargo aircraft the usual method of estimating indirect cost—as a percentage (based on past experience) of direct cost—could be misleading. Meanwhile, it was important that the assumptions used in estimating direct costs should be valid and realistic.

A direct operating cost of about 4 cents/ton-mile, using realistic assumptions, would, nevertheless, be of little significance if indirect cost elements remained high. Canadair therefore established design criteria for an integral mechanized cargo-handling system which would permit the loading of a full-capacity payload in 45 minutes—thus permitting a turn-round time of about an hour. The system consists of a chain drive which carries pallets or containers from the loading sill to their position in the cargo compartment. The operator will still retain the choice between bulk loading and pallet or container loading in the make-up of the total payload.

There are, in the CL-44, four freight compartments—the main hold, the forward and aft underfloor compartments, and the hinged tail section. The main hold has a clear volume of 5,528 cu. ft. when bulk loaded, or one of 4,714 cu. ft. when using pallet or airborne-container loading. The forward underfloor compartment is of 487-cu.-ft. capacity and will normally be bulk loaded. The aft underfloor compartment has a volume of 524 cu. ft.—giving an effective 400 cu. ft. if four preloaded bins are used for the cargo. The clear volume (711 cu. ft.) of the tail section is reduced to 551 cu. ft. when preloaded containers are used. The total volume available is thus 7,250 cu. ft., reduced to 6,152 cu. ft. when pallets and/or bins are used. The system weight, using pallets, is 3,100 lb.

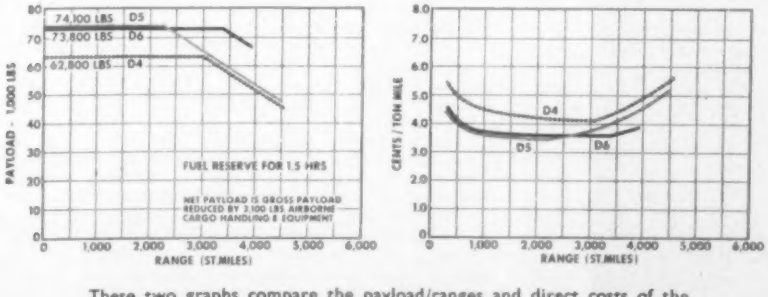
The Canadair pallets are flexible and each has a design load capacity of 8,000 lb. Eleven pallets, or containers, or a combination of the two, make up the load in the main compartment, where the loaded pallets are restrained by the side channels (which provide the entry-guidance system) and by 9*g* barrier nets between the pallets. A pre-attached throw-over net on each loaded pallet controls the load contour. The whole system is now in its functional test stages.

But the success of such a system obviously depends on ramp and terminal layout. Freight warehouses will need to be mechanized to the point at which maximum payloads can be loaded and unloaded within a normal aircraft-servicing turn-round time. The present average manual loading time, for converted passenger aircraft, of about 30 minutes per 10,000 lb. will be reduced to 3-4 minutes and the terminal arrangements must be organized to suit.

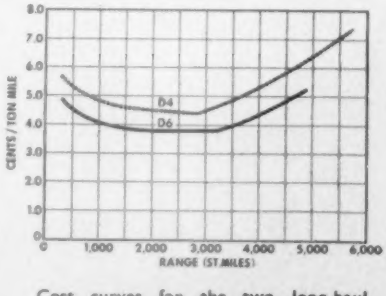
	CL-44D4	CL-44D5	CL-44D6
Powerplants	R-R Tyne 12	R-R Tyne 14	R-R Tyne Stage IV
Take-off power (e.h.p.)	5,730	5,730	6,445*
Max. take-off weight (lb.)	205,000	205,000	225,000
Max. landing weight (lb.)	165,000	175,000	175,000
Max. zero fuel weight (lb.)	155,000	165,000	165,000
Max. payload (gross) (lb.)	66,128	77,392	76,958
Cargo volume (gross) (cu. ft.)	7,250	7,250	7,250
Operating weight empty (lb.)	88,872	87,608	88,042
Cruising speed (m.p.h.)	394	400	407
at weight (lb.)	165,000	175,000	175,000
at altitude (ft.)	20,000	15,000	16,000
Range with max. payload (st. miles)	3,050	2,200	3,350
F.A.A. take-off field length required (I.S.A., s.l., max. wt.) (ft.)	7,660	7,660	8,350
F.A.A. landing field length required (I.S.A., s.l., max. landing wt.) (ft.)	6,780	7,080	7,080

* To I.S.A. plus 17°C.

As already reported (the issue of Dec. 25, 1959, p. 652), Canadair have, assisted by Flying Tiger, been analysing present air cargo as the first phase in a major cargo-research programme. The work has been completed and phase 2 of the programme has now been started. This involves a study of surface-cargo movements to determine the types of commodity which could more profitably be distributed by air.



These two graphs compare the payload/ranges and direct costs of the three CL-44D variants when operated on U.S. domestic services. The costs are based on a rationalized all-freight formula developed by Canadair.



Cost curves for the two long-haul CL-44D variants when operated on U.S. international services.

Air Transport . . . .

The F.A.A. and Decca

LAST January the U.S. Federal Aviation Agency issued an advance summary of its report on the Decca system as evaluated using the Bendix-Decca New York chain and Mk. 10 equipment flown in a Convair C-131 (CV-340). This summary (see our issues of January 15, p.62, and January 22, p.96) dealt with only a part of the story.

The chain was laid down primarily for the evaluation of its potentialities as a helicopter navigation aid and the more important report was that covering the use of Mk. 8 equipment during the first phase of the Agency's helicopter operations programme. The report on which the original summary was based forms, in fact, a supplement to the helicopter report.

The well-documented full reports have now been issued by the F.A.A. and we obtained copies in mid-February. Since these had then only just reached the Decca Navigator Company in London it seemed to be no more than fair to delay any further references until the company's own interpretations had become available—which they did towards the end of last week.

So far as the helicopter evaluations, using the Mk. 8 receiver, are concerned, the F.A.A.'s conclusions may be summarized as follows:—

1. The airborne system components require an excessive amount of pilot time to set up, operate and use.
2. The basic electronic accuracy of the components was well below the high accuracies stated in published descriptions of the system.
3. Errors due to charting and presentation problems are greater than the basic electronic errors.
4. The system did not provide the basic accuracy usually associated with a final approach and landing aid.
5. The demonstrated operational reliability of the system's components did not meet the standards usually associated with equipment used for primary IFR guidances.
6. The system lacks fail-safe features.
7. Problems associated with charting render such systems inflexible, with their use restricted to fixed route and terminal sequencies.
8. Within the accuracy and other operational and technical limitations described, the Mk. 8 may be useful as an en-route aid for low-flying IFR helicopters in certain areas and operating conditions, and assuming duality of equipment, the availability of supplementary aids and the introduction of fail-safe features.

The main conclusions in the supplementary evaluation report on the Mk. 10 as a fixed-wing aircraft aid were that, "when working properly," it provided easy-to-read general orientation and track-history data and was somewhat easier to manipulate than earlier Decca systems. It did not, however, meet the principal requirements for a primary navigational aid because:—

1. It did not provide steering information.
2. Two pilots were required in many A.T.C. environments.
3. Charting problems limited the system to use in carrier-type operations over fixed routes.
4. Operational reliability was below IFR primary aid standards.

Decca's comments deal with the supplementary Mk. 10 report, but make pointed reference in the introductory matter to the fact that New York Airways have continued to use Decca equipment since the F.A.A. helicopter trials were completed and that provision is also being made for dual Mk. 8 equipment in their Vertol 107s.

The comments deal first with the section of the Agency's report in which "yes," "no" and "no comment" percentages were given for pilots' replies to various questions. These were arbitrary and usually without operationally significant quantitative bases, and the answers were, in at least one case, contradictory. The percentage of "no comment" answers was, in Decca's view, "absurdly high" in relation to the types of question being asked. On that, for instance, of whether Decca could be used as an approach aid in four different minima conditions, there were about 85% "no comments." Of those who did answer positively, 16.3% found it possible to use Decca down to 200 ft. on the approach, whilst only 1.9% could do so down to 1,000 ft.

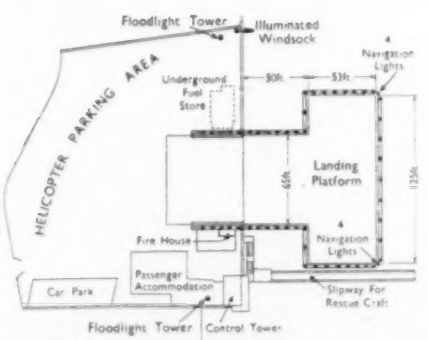
Commenting on detail criticisms in the body of the report, Decca points out that the published charts show no off-track deviations greater than ±.5 n.m. except in the Boston area and that, though the cause of losses of zone identification at intermediate ranges were diagnosed and corrected by Decca later during the tests, no mention was made of the fact.

In concluding comments, Decca agrees that there were grounds for criticism, but that the limitations of the short baseline low-power New York chain were not appreciated by the F.A.A. The report reveals a clear requirement for a comparative side-by-side evaluation of Decca and VOR/DMET.

Heliport Cleared for Night Flying

WESTLAND'S London heliport at Battersea has been licensed for night flying following the installation of G.E.C. lighting equipment. The heliport opened for daylight operation less than a year ago—on April 23, 1959—and has had an average of about 150 movements a month since then. The lighting, installed at a cost of about £1,700, consists of medium-intensity elevated perimeter lights round the edge of the landing platform, and floodlights mounted on towers. Nearby obstructions are marked, and an angle of approach indicator has been provided.

The last-mentioned piece of equipment shows the pilot a flashing green light when he is correctly aligned on the 12° approach path. If the pilot is too high or too low, he sees red or amber lights, respectively.



The perimeter lights have been mounted on the fenders which surround the T-shaped landing platform and connecting taxi-strip to the parking apron. They are modified versions of the G.E.C. medium-intensity elevated runway light, spaced 15 ft. apart along the long outer edge of the platform and 7 ft. apart along the two ends. Flame-proof taxi lights flank the sides of the taxi strip at 7 ft. intervals. To overcome the danger of pilots being dazzled by the lights as they land, their brightness can be controlled in five stages—100, 60, 30, 10 and 3 per cent. of maximum intensity.

On each side of the parking apron is a 40-ft. tower carrying four 1-kilowatt apron floodlights—two to illuminate the landing platform and two for the apron. Either one of these towers is used according to the approach direction of the helicopter. All lights are controlled from the I.A.L. control desk in the tower, including the illuminated windsock, obstruction lights, river navigation lights, apron wall lights and slipway lights.

The lighting installation at Battersea complies with recommendations by the Ministry of Aviation in collaboration with B.E.A. Helicopter Experimental Unit and independent helicopter pilots.

The Fighting Services

Equipment for the R.A.F. 1960-2000

NO lecture before any branch of the Royal Aeronautical Society is likely to have a more distinguished audience than the one which attends the Trenchard Memorial lecture before the Halton Branch of the R.Ae.S. This year the lecture was delivered by Sir George Edwards. The chair was taken by Air Marshal Sir Wallace Kyle, A.O.C.-in-C. Technical Training Command. The dowager Lady Trenchard was indisposed. Lord Trenchard was abroad but the Commandant of No. 1 School of Technical Training at Halton, Air Cdre. T. N. Coslett, was host to no less than seven A.O.C.-in-C.s for the occasion. Present were: Air Marshal Sir Kenneth B. B. Cross (Bomber Command), Air Marshal Sir Edward Chilton (Coastal Command), Air Marshal Sir Denis H. F. Barnett (Transport Command), Air Marshal Sir Hugh A. Constantine (Flying Training Command), Air Vice-Marshal Sir Leslie Dalton-Morris (Signals Command) as well as the Controller of Engineering and Equipment, Air Marshal Sir Herbert B. Spreckley, President of the Halton Branch of the Society and Air Vice-Marshal J. Marson (Air Officer Commanding No. 24 Group) who is Vice-President of the Halton Branch, and Mr. A. J. Murphy, principal of the College of Aeronautics at Cranfield.

At the dinner which followed the lecture, the President of the Royal Aeronautical Society, Mr. Peter Masefield, said "thank you" for the guests. Dr. Ballantyne, secretary of the Society, was seen to be taking thoughtful, and somewhat envious notice we thought, of the Halton pipers who skirled their pipes through galleries and down the great stairway of the fabulous Rothschild mansion which was given in perpetuity to the Royal Air Force.

The survey given by Sir George Edwards was in keeping with the stature of the man whom the occasion had been fashioned to honour. It had breadth of vision, it manifested the conviction of the lecturer and there can be no doubt of the courage of an engineer designer who is prepared to lay before an audience of experts a survey of what equipment the Royal Air Force is going to be using over the next forty years.

The basic idea had a fascination of its own. There is nothing, Sir George observed, to stop a cadet from Halton becoming C.A.S. of the R.A.F. To climb the ladder from the lowest to the highest rung would occupy some thirty-five years. It would surely be interesting then to survey the equipment of the Royal Air Force during the Service career of such a hypothetical cadet. Thus the period under review would be spread from the present time until 1995 or, for convenience, until the year 2000. This could be usefully divided first into the ten years until 1970, during which time we know pretty well from published material what has been planned to happen. Treatment of the subsequent period would have to be more speculative.

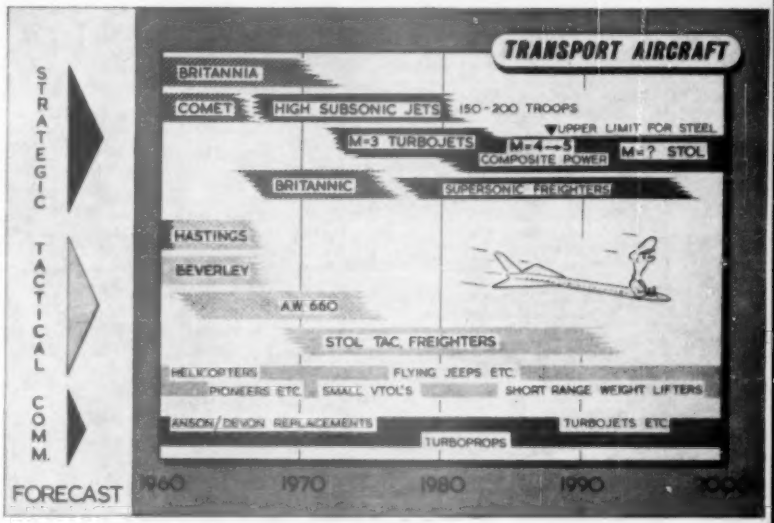
The method adopted by the distinguished lecturer to present such a survey was graphical. The gaily coloured slides were explicitly graphic and the audience appreciated the humorous embellishments on some of them. That the facts were salted with what Mr. Masefield described as "Georgian" wit made them the more memorable.

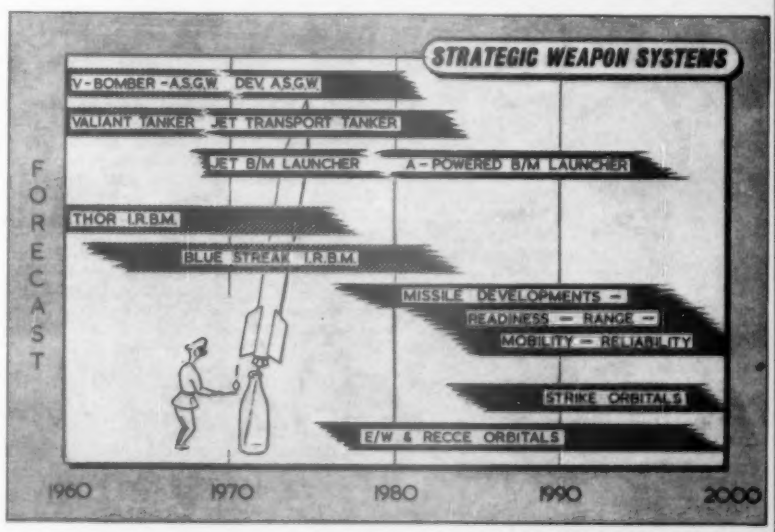
Sir George began by surveying the period 1960-70 and to do this he took six broad divisions: strategic weapon systems, transport, tactical and limited war systems, air defence, maritime reconnaissance and, in conclusion, space travel and research. So far as the V-bombers are concerned, their future extends through the decade and with the development of the air/surface guided missile may be expected to go on until 1980. By that time Thor will have been phased out in favour of Blue Streak.

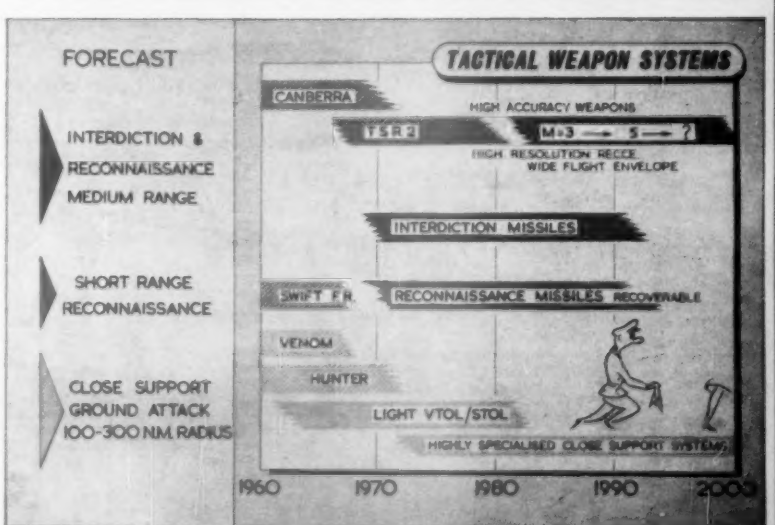
Surveys of the other fields were made in the same vein. It is interesting to note that the future of the TSR 2 is seen as going on into 1980.

It was in the section devoted to space that Sir George made some memorable remarks anent the Russians. A great difference between them and us is that the Russians assume that women have brains and use them. Also, when the man at the top says "Go" everyone in the Government or other circles either helps or gets out of the way—not in it.

The next stage of the survey begins in 1970 when the hypothetical cadet has become a Flight Lieutenant. In surveying the background to this period various epigrams were coined. One or two of them must be recorded: "An adequate aircraft at the right time is better than a perfect







The Fighting Services . . . .

aircraft too late." "All of us support the principle of disarmament but there are two essential things to recognize and remember: first, unilateral disarmament will get us nowhere; second, effective negotiation toward disarmament (like mergers) will only be achieved from a position of real equality of strength."

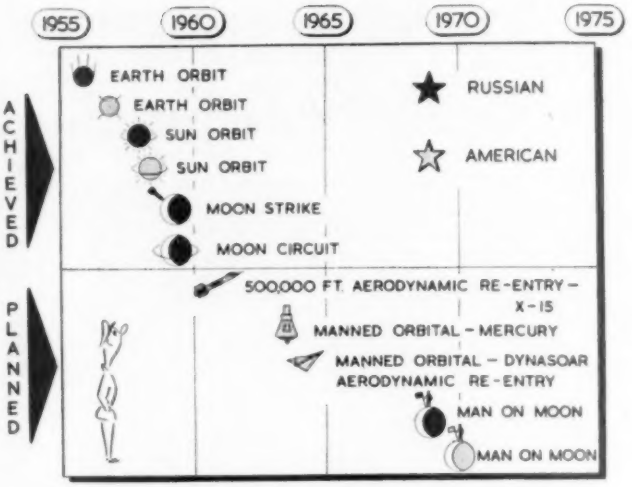
The series of slides for the 1970-2000 section began with that covering transport aircraft. The reasons were four: the emphasis in the White Paper had been on mobility; big aircraft are now so costly that they must be able to duplicate rôles; there is the impact of their cost on the National Economy; Mr. Sandys had spoken of the intention to combine military and civil needs.

Sir George hazarded a guess that in the mid-'sixties a high subsonic jet transport would come into R.A.F. service with the rôle of strategic transport with freight and other capabilities. In this connection Sir George expressed some vigorous views about military freight. "You do not," he said, "carry around the World in two million pound aeroplanes such things as Jeeps, field kitchens, bulldozers and beer. It is cheaper to acquire them locally, or to stockpile them locally. You only carry round high-class freight—things you cannot afford to stockpile or can only afford to have in relatively small quantities concentrated at home. The Army must appreciate this." He sees such a machine carrying men, military freight, fuel for in-flight refuelling, fuel for logistic support, missiles and other expensive equipment deployed from the central reserve and perhaps ballistic missiles for air launching.

This was followed by some speculation about the supersonic transport. In the course of this some fascinating facts about kinetic heating were deployed.

Next came discussion of what sort of strategic weapon systems were to be expected in the years after 1965. Sir George believes that we shall come to an atomic-powered aeroplane capable of launching ballistic missiles.

He had much to say about tactical weapon systems and he sees the need for these continuing far into the future. Explaining why he is an advocate of STOL rather than



VTOL, he noted that there are thousands of small- and medium-sized airfields in the World. It would be sensible to make an aircraft that could use them. It is difficult enough to produce an aircraft which combines short take-off and landing, with high supersonic performance over a wide weight band, the ability to operate for long periods at low level and at high speed, and long range. It is still more difficult to associate these qualities with vertical take-off and landing.

At the end his hearers could have been in no doubt that the Royal Air Force is going to want pilots and engineers as far as, and then on into the Space Age. And what an exciting technical experience it is going to be.

Royal Tournament News

GROUND-TO-AIR missile defence will be the main theme of the R.A.F.'s principal display at this year's Royal Tournament at Earls Court, between June 22 and July 9. The arena is to be transformed into a set piece to show how the Fighter Command early-warning radar system operates, together with the deployment of fighters, equipped with Firestreak AAMs, and Bloodhound SAMs against enemy raiders. The Bloodhound target radar lock-on technique will be demonstrated and a model of the missile is to be "fired." A large-scale projection of a film showing the impact of such a missile on a target aircraft will also be seen.

Other R.A.F. items in the Tournament will include a demonstration by the Ceremonial Drill Unit at Uxbridge commanded by Sqn. Ldr. K. Courtnage.

Looking for Members

THROUGHOUT the World there are approximately 150 ex-R.A.F. and Commonwealth Air Force aircrew personnel who, although entitled to wear the Battle of Britain clasp, are not members of the Battle of Britain Fighter Association. With this fact in mind, the Association has now launched a drive to trace these "lost" clasp holders, who, in turn, are invited to write to the Association's Secretary at the Air Ministry (Room 0211), Whitehall, London, S.W.1.

Formed two years ago, the Association aims to look after the welfare of its members and their dependants; to preserve the memory of fighter aircrew who died in the Battle of Britain; and to foster friendship among its members.

In Squadron Service

AFTER what must be the quickest military aircraft development and trials programme in recent years, the Fairey Gannet AEW.3 has now entered squadron service with the Fleet Air Arm.

No. 700 "G" Flight (Lieut. Cdr. W. Hawley, R.N.), which undertook the aircraft's intensive flying trials at R.N.A.S. Culdrose, has been disbanded and reconstituted as "A" Flight of No. 849 Squadron. It will join the carrier "Ark Royal" when she embarks her aircraft (Scimitars and Sea Vixens) this month.

Formed in August, 1959, a year after the maiden flight of the first prototype, No. 700 "G" Flight had logged 1,855 hours by January 31, 1960, with a maximum of three Gannets available at any one time. This number of hours in a period of 24 weeks is believed to be a record for a new type of operational Naval aircraft.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Wg. Cdr. J. L. Schooling to the Department of the Air Member for Personnel.

Bomber Command: Gp. Capt. G. H. Everitt, D.S.O., O.B.E., D.F.C., to R.A.F. Gaydon to command.

Fighter Command: Wg. Cdr. A. C. Rawlinson, O.B.E., D.F.C., A.F.C., to R.A.F. Buchan to command, with the acting rank of Gp. Capt.; Wg. Cdr. S. J. Perkins, A.F.C., to R.A.F. West Malling to command No. 85 Squadron.

Technical Training Command: Gp. Capt. G. M. Robinson, D.F.C., to R.A.F. Cardington to command; Wg. Cdr. P. R. M. Groom to No. 4 School of Technical Training, R.A.F. St. Athan, as Senior Equipment Officer.

Maintenance Command: Wg. Cdr. F. Parvin to Headquarters for trade testing and training duties.

Other Appointments: Gp. Capt. W. D. G. Watkins, D.S.O., D.F.C., D.F.M., and Sqn. Ldr. H. B. Alty, M.B.E., both to the Ministry of Aviation, the latter with the acting rank of Wg. Cdr.; Wg. Cdr. A. W. Pink, O.B.E., to command the R.A.F. element of the Travel Control Security Group; Wg. Cdr. J. K. Rogers to Allied Air Forces Northern Europe for staff duties.

More Service News

C.F.S. Reunion.—This year's reunion dinner of the Central Flying School Association is to be held in the Officers' Mess, R.A.F. Little Rissington, on Friday, July 8. Full particulars will be circulated to all members in due course by the Honorary Secretary.

Coastal Command Reunion.—The annual reunion of Coastal Command Officers will be held in the Officers' Mess, Headquarters Coastal Command, R.A.F. Northwood, on Saturday, May 7. Particulars and tickets, price 15s. each, may be obtained from the Hon. Sec., Wg. Off. S. P. Titcombe, O.B.E., W.R.A.F., at Command Headquarters.

R.C.N. Appointment.—Lieut. Cdr. K. S. Nicolson, R.C.N., is to take over command of No. 870 Squadron, Royal Canadian Navy, next month. Equipped with Banshees, the Squadron operates either from the carrier "Bonaventure" or the naval air station H.M.C.S. "Shearwater."

The Commonwealth's Cape Canaveral—1

Following his first visit seven years ago CHRIS WREN *recently returned to Woomera. His report on the great Australian establishment begins this week.*

WHAT is broadly and often rather vaguely referred to as "Woomera" is more correctly called the Weapons Research Establishment, a title which in 1955 replaced the original name of Long Range Weapons Establishment. Because of its important place in current and future World events and its fascinating location, it is an attractive proposition for any

STEWART SCOTT-HALL Head of U.K. M.o.A Staff, Australia

JOHN L. KNOTT Secretary, Department of Supply

journalist, and when I knew I was likely to be making my third visit to Australia I got in touch with Charles Huntly, of the Ministry of Aviation, who deals with us Press types, and he cabled Mr. Stewart Scott-Hall, Head of U.K. M.o.A. Staff in Australia.

Now whether the fact that I'd been to Woomera before, and behaved most circumspectly, had anything to do with it, I don't know, but the Commonwealth Government stretched out the usual Australian hand of welcome and I was in. This is a good place to express my thanks to everybody who had a hand in sanctioning, arranging and conducting a high-pressure tour which M.o.A. and the Australian Department of Supply managed faultlessly. And I must thank Trans-Australia Airlines for transporting me from Sydney to Melbourne and Adelaide and back in the lap of jet-proper luxury.

The Australian branch of M.o.A., headed by Mr. Scott-Hall and his Secretary and Financial Adviser, Don Syme, has its modest offices in the same Melbourne building as the Australian Department of Supply. Here I met Mr. John Knott, Secretary to D. of S., and his senior staff members, Alan Butement, Chief Scientist; Dr. Ben Gates, Controller, Research and Development; Eric L. Cook, Asst. Sec., R. and D., the first Australian to be permanently associated with the Joint Services Project and a leading Australian historian; Bill Sumner, Dep. Sec., Chairman of the Contracts Board and, in his time, a fine cricketer; and Ian "Jindivik" Fleming, Controller, Aircraft and Guided Weapon Supply, the man who led the team responsible for the very successful Australian Jindivik target aircraft and the Malkara ground-to-ground missile.

Australia is no less civilized than England in the provision of morning coffee and Stewart Scott-Hall and his competent Personal Assistant, Miss Jean Jamieson, maintained the hospitable custom while explaining my itinerary. From Melbourne, T.A.A. were to fly me the 420 miles to Adelaide where a car would take me to the W.R.E. base at nearby Salisbury. Then I would fly the 300 miles from Salisbury's airfield, Edinburgh, to Woomera, and subsequently return along the same route.

On my earlier visit I had learned something of the history of W.R.E., which celebrates its thirteenth birthday on April 1. Because the Establishment's background and general set-up appear to be little known to many people, and of interest to them, here they are in outline.

The W.R.E. Story

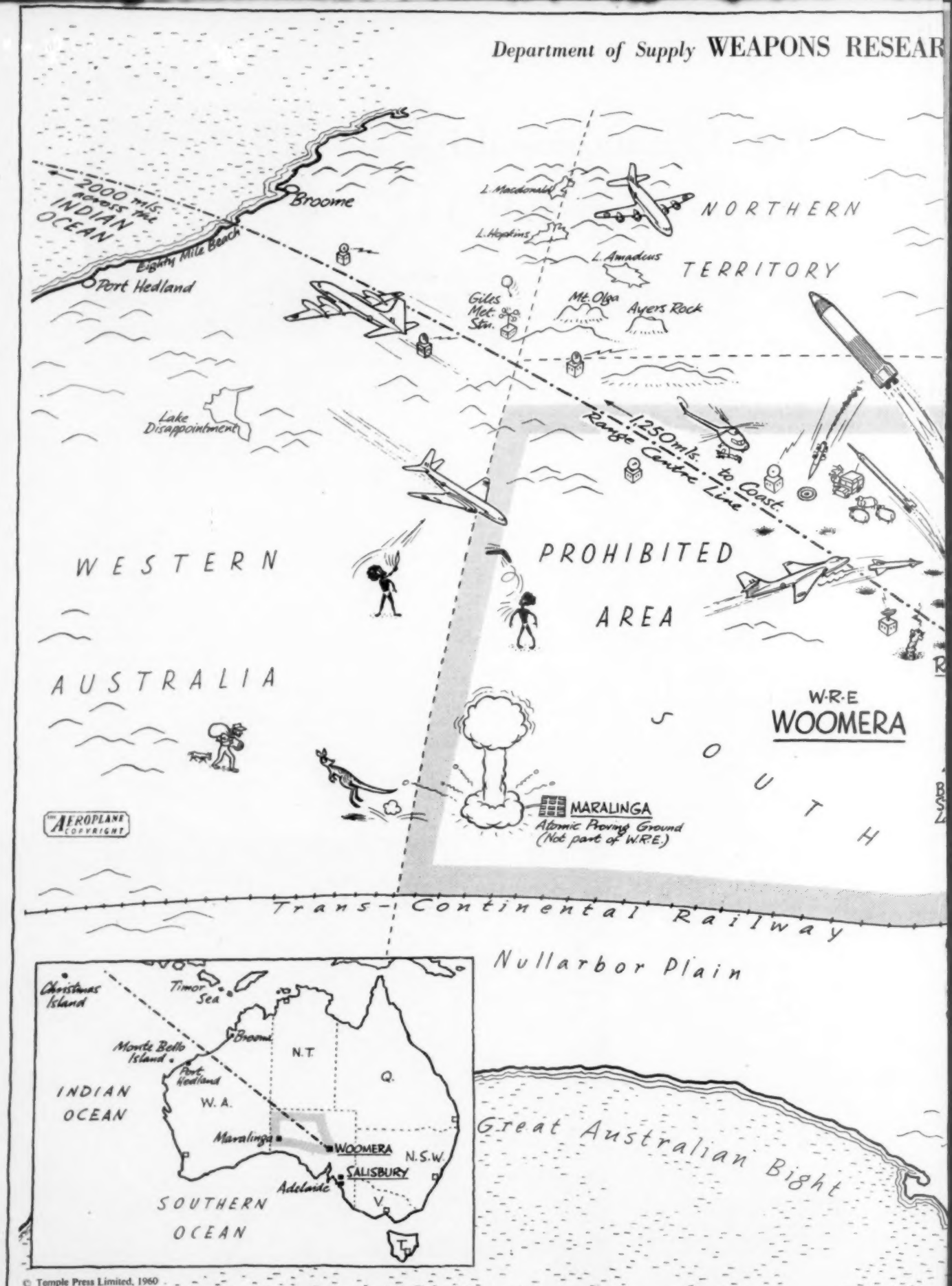
The need, in 1946, for a long range for testing and developing the then new armament, the guided weapon, led to a survey being made in the British Commonwealth by representatives of the Ministry of Supply and the Ministry of Aircraft Production under the leadership of Lt.-Gen. J. F. (now Sir John) Evetts. The South Australian area selected might almost have been made for it.

At Salisbury, there was immediately available an empty ex-wartime explosives factory of 1¼ million sq. ft., complete with office blocks, transport facilities, and security arrangements, where laboratories, workshops and preparation facilities could be concentrated. Some housing also existed and Adelaide was only 17 miles away. There was a suitable site for an airfield alongside and this was constructed in the early '50s and named Edinburgh.

The Trans-Continental Railway, which was available, ran to

(*Continued on page 282*)

Salisbury, ex-munitions factory 17 miles north of Adelaide. The W.R.E. headquarters, laboratories, main workshops and contractors' headquarters are located here.



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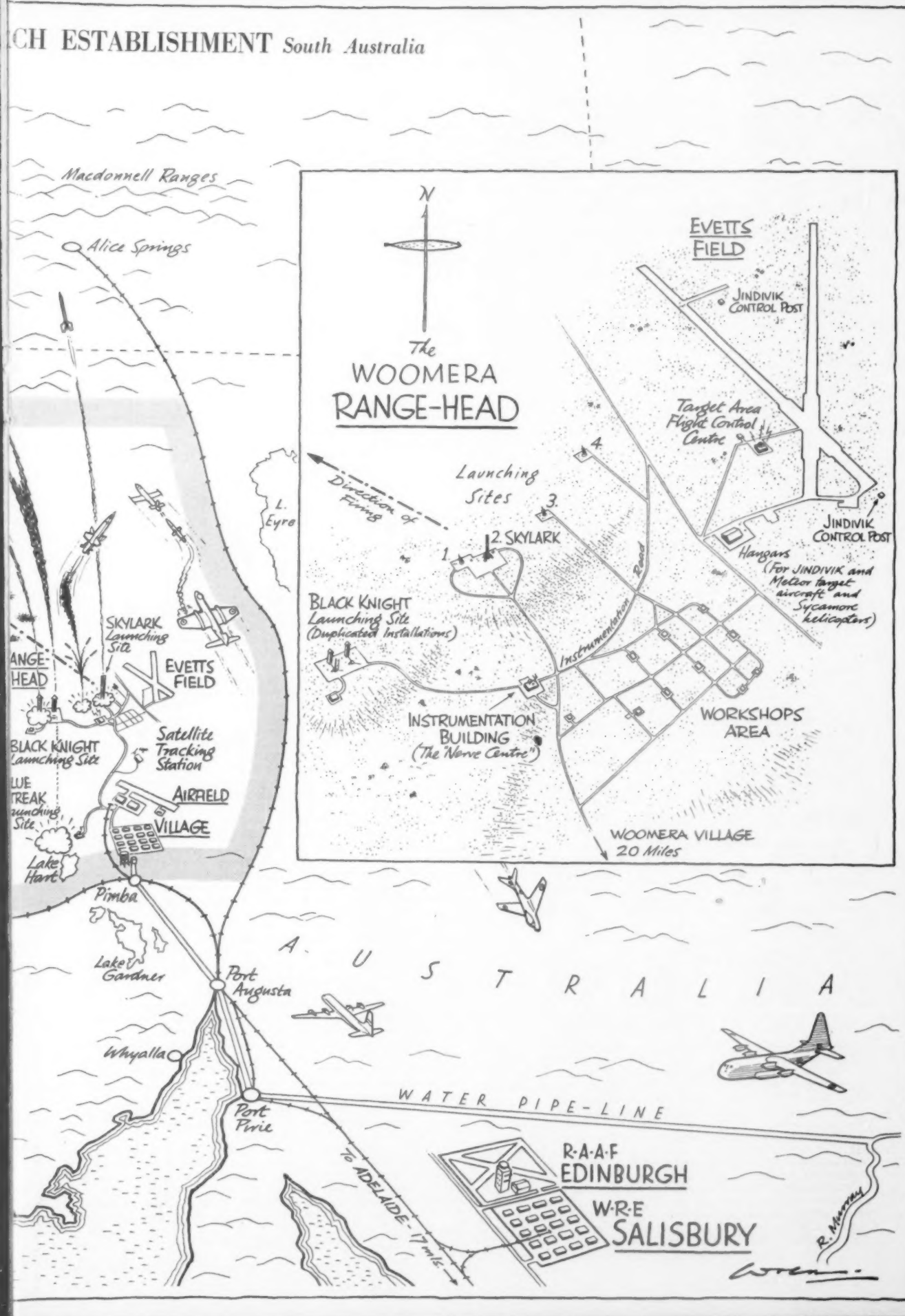
CH ESTABLISHMENT *South Australia*



MEN OF MELBOURNE - Department of Supply members concerned with W.R.E.
ALAN BATEMENT Chief Scientist
DR. BEN GATES Controller R&D
ERIC COOK Asst. Sec. R&D.
BILL SUMNER Deputy Sec., D. of S.
IAN FLEMING Controller, Aircraft & G.W. Supply

(*Continued from page 279*)

and beyond a place called Pimba, some 300 miles north, in the south-east corner of the great central and western deserts of Australia. A site just north of Pimba was examined and recommended for a range head.

From this it would be possible to fire a distance of 1,250 miles towards the Western Australian coast over areas which were practically unpopulated (by people, anyway—the range area now has the best part of a million sheep on it and almost as many kangaroos) and, if necessary, a further 2,000 miles over the Indian Ocean was available. The United Kingdom and Australian Governments decided that these sites were the best available and the project was begun officially on April 1, 1947.

Salisbury

The great Australian distances, both from U.K. (about 12,000 miles) and within itself (Darwin-Sydney is 2,000 miles, some 200 miles greater than the distance from London to Istanbul) are now being annihilated by ever-faster air travel. Thus W.R.E.'s chief disadvantage, its distance from Great Britain, has become less onerous and they are now only two days apart.

A T.A.A. "Super-Viscount" took about 1¼ hr. to fly me from Melbourne to Adelaide over the thickly wooded and undulating State of Victoria and the vineyards of the south-eastern fringe of South Australia. During the drive to Salisbury, the D. of S. driver told me that the State had been virtually rainless for several months and now in the summer the dry surfaces were being whipped into large dust clouds.

At the W.R.E. gates, a brief and friendly formality produced my Visitor's badge and I was escorted along the headquarters' building's cool corridors to meet Capt. Jack Newman, Royal Australian Navy (Retd.), who was for the period 1954-59 the Range Superintendent and is now Salisbury's P.R.O. and enjoying his new job. The Superintendent (Commanding Officer) appointment is held in turn by a senior officer of each of the Australian Services. When I previously visited the Establishment, Gp. Capt. George Pither, R.A.A.F., was Superintendent, then Capt. Newman did his stint, and later at Woomera, I was to meet Col. Richard Durance, Australian Army, the present Superintendent.

At Salisbury, the head man bears the title of Controller, the current holder being R. W. M. Boswell, previously Deputy Controller. To Bill Boswell, big and amiable, I owe my thanks for much of the information in this account. He was my host at

"What is your visitor interested in — WREDAC, WRECISS, Doppler, Sub-Miniature Telemetry...?"
MATHEMATICAL SERVICES WING
DON OVERHEU Snr Scientific Officer
CAPT. JACK NEWMAN, O.B.E., R.A.N. Public Relations Officer

a highly entertaining lunch with his senior staff, H. Arthur Wills, Deputy Controller, Trials and Instrumentation Wing; Dr. M. W. Woods, Dep. Con., Weapons Research and Development Wing; Harold T. Loxton, Dep. Con., Planning Wing; and Tom J. Woolcock, Chief Admin. Officer.

In planning the Establishment's disposition, it was clear that the most economical way to operate was to concentrate at Salisbury the laboratories, workshops and preparation facilities so that the minimum number of personnel would require accommodation in the semi-desert region at Woomera. The difficulties in operating a range separated from its base by 300 miles have been overcome to a great extent by provision of direct telephone and teletype links and the institution of a daily courier aircraft service which moves staff from one place to the other in less than two hours. For heavy stores, surface communication by rail and road takes some 10 hours.

Because of the distance from Great Britain the U.K. missile contractors carry out as many trials as possible on the ranges near their U.K. factories, and the Australian Establishment normally has several years' notice of their intention to come to Australia. This has enabled W.R.E. to adopt a policy whereby instead of immediately installing a general-purpose range, which may or may not satisfy future customer requirements, the installation of facilities and instrumentation can be delayed until a definite request is received from a contractor for a particular type of trial.

The customer's problems are then recorded in a planning specification and he is presented with a facilities plan which, it is hoped, will meet his requirements. This procedure has made for considerable economy, has prevented W.R.E. from committing the range to out-of-date equipment and has afforded continual stimulus to furnish the appropriate instrumentation for the requirements as they arise.

The trials wing, whose function is to plan and execute all guided-missile trials and to process the data arising from them, is organized into four divisions. It has a missiles projects group which liaises with contractors (whose head offices and workshops are at Salisbury) and prepares a trials instruction, the executive document which specifies in some detail the facilities and measurements required of the range.

The ranges group, at Woomera, then sets up and carries out the trial, the results of which are processed by the mathematical services group who provide the contractor with data reduced to a form specified by him. It is with this division that the contractor has most contact.

The optical and mechanical instrumentation division and the electronic instrumentation division provide the trials instrumentation required at Woomera, and they may procure from the U.K. or elsewhere the appropriate equipment or may develop within their own laboratories at Salisbury other systems which may be required. Broad requirements might call for a complete optical or telemetry system, while technical developments might involve improving lens design or developing new aerials or receivers. In the United Kingdom or America, this support would probably be available from the Universities or large manufacturing firms, but because of the isolation and the comparatively small amount of industry in Australia it has been found necessary to provide much of it within the Establishment.

Lastly, there is the systems assessment division. This is not concerned with the research and development trials carried out by contractors on their missiles but, in conjunction with R.A.E., designs and carries out the acceptance trials of these weapons.

The personnel of the trials wing is basically civilian and now composed almost entirely of Australians, although great help was rendered by secondment of many U.K. personnel in the project's early days. The Establishment is supported by quite a number of Servicemen but, in general, they are employed in positions for which they have already had Service training or where the range experience would be of value to the particular service. For instance, the complete air support of W.R.E. is provided by the Royal Australian Air Force, while Army personnel operate the radar equipment and handle explosives.

With the exception of the ranges group, the entire wing is located at Salisbury, adequately housed in buildings already existing. The only new construction in the Salisbury area has been Edinburgh airfield. The R.A.A.F. policy is similar to W.R.E.'s in that they maintain at Woomera a trials unit whose main function is to provide target services, at present with Jindivik and Meteor aircraft, and concentrate back at Edinburgh their support units—and from there, if the range of the aircraft permits, they mount the air support for the trials.

Salisbury is so extensive and the numbering of its many buildings so haphazard, apparently (No. 24 adjacent to No. 79), that Capt. Newman hadn't yet discovered the location of some of the places in his new diocese. Nevertheless, he laid on a pretty comprehensive tour, including the Mach 1.8-2.6 wind-tunnel and WREDAC (WRE Digital Automatic Computer) which Arthur Wills thought might be renamed the "WRE Wready Wreckoner" to mark Wren's visit.

In the mathematical services wing, Don Overheu, Snr. Scientific Officer, took me on a tour of his trials assessing devices, some of them operated by girls. After watching these young ladies dexterously laying off angles on film frames of missile trials and turning them into material easily digestible by computers, I lurched out into the Australian sunshine, humbled.

(*To be continued*)

MATERIALS AND PROCESSES

This 12-page supplement is devoted to certain aspects of materials development and production processes related to the new generation of large supersonic aircraft and steel airframe components.

1 Sandwich Structure

Its Development and Application to Transonic and Supersonic Aircraft and Missiles.

By H. R. Ashley, A.F.R.Ae.S., A.M.C.T.*

TO achieve high aerodynamic efficiency and also to improve structural efficiency, the onset of buckling on the compression side of a wing structure must be delayed to a stress level not much below the tensile proof stress of the material being used. There are several ways of doing this.

Usually the desired result is achieved by arranging the cross-sectional area required into a stable configuration which does not fail by premature instability, using either closely pitched stringers, integrally machined stiffeners, corrugated stiffeners or corrugated sandwich. A further method is to add stabilizing material, generally done by sandwiching honeycomb core between two sheets, each of which is approximately half the original single sheet thickness.

Honeycomb-stabilized structure is only one of the family of sandwich structures, and in itself has several variants. Fig. 1 illustrates several types of stabilizing core, all of which have to some degree different properties in the two directions of the plane because of the manufacturing methods that are employed. For this reason they have been divided simply into the categories of having either axial load carrying or non-axial load carrying cores.

The axial load carrying corrugation-stabilized sandwich has developed from the time when the corrugation itself was used for external skinning. The Junkers 52 used this form of skin to cover both fuselage and wing structure in 1932.

Further developments later in the decade were made by Sir W. G. Armstrong Whitworth Aircraft, Ltd. Their application of corrugation to the Ensign wing structure in 1937 used the corrugation in a spanwise direction, the skin covering being carried by rib members laid over the corrugation.

Later the same year, the Whitley aircraft was produced with the outer skin attached directly to the spanwise corrugation. Also, the tension field shear resistant web was employed with the corrugations running vertically. This feature has come into prominence again quite recently as a method of reducing thermal stresses when using the high temperature resistant materials for very high speed structures.

The employment of the double-skinned corrugated sandwich to resist axial loading can give a very high structural efficiency. This type of structure has been used in several aircraft designs, the A.W.A. 52 flying-wing in 1947, for example, and other, more recent, aircraft.

An objection to using light-alloy structures of this form is the same as that which obtains when using closed top-hat or bowler-hat section stringers, in that the internal faces cannot readily be examined for corrosion deterioration during service. This is particularly important if the assembly is spotwelded, as this process itself forbids the use of corrosion protection in detail. Thus, the advantages of the all-spotwelded double-skin corrugated sandwich can only be utilized when the material required has good corrosion resistance, such as stainless steel or titanium alloys.

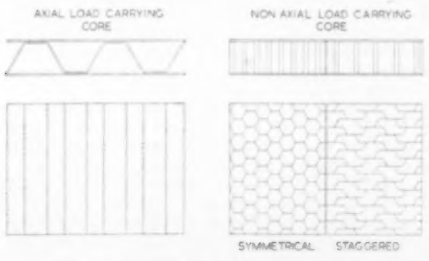


Fig. 1. Forms of sandwich construction (top skin removed in plan views).

A particular answer to the high-panel-loading problem of the thin wing structures of a high-wing-loading, "high-g" fighter can be found by using stretched plate material, machined or chemically milled into the desired configuration. This interesting development is, however, a subject in itself.

Honeycomb-stabilized Sandwich

The corrugation-stabilized sandwich is constructed by orthodox and long standing jointing methods, such as riveting, pop-riveting or spotwelding. In contrast, the introduction of the thin-foil honeycomb core stabilization was delayed until the advent of metal bonding techniques, as established in Europe by Dr. de Bruyne of Aero Research—now CIBA (A.R.L.).

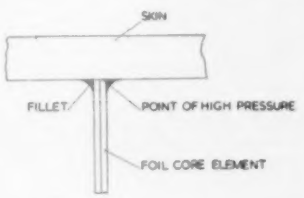


Fig. 2. Joining honeycomb core element to facing material.

There are many variations of temperature and pressure curing cycles for the various metal bonding adhesives, so care has to be exercised in selecting the right combination for the purpose required. The first principle to be remembered in honeycomb assembly is that it is only possible to get high contact pressures at the knife-edge intersection of the honeycomb core and the face sheet (Fig. 2).

For this reason the advantages of an adhesive which demands the use of high pressure during the curing cycle cannot be fully realized, as any fillet formed using such adhesives will not be subject to sufficient pressure, and will be crumbly and brittle. Thus preference must be given to the low-pressure fillet-forming adhesives such as Araldite. It is for this reason that there is great difficulty in producing satisfactory "medium" temperature (150° C.) honeycomb structures using the modified phenolic type of adhesive.

The general principles of light-alloy honeycomb fabrication and manufacture by A. V. Roe have been described in a previous article by A. Holt (THE AEROPLANE, June 20, 1958). The various standard cell sizes and foil thicknesses used, and panel weights per square foot are given in this reference; also the approved inspection methods used to ensure production reliability are described.

It might be argued that the honeycomb assembly is subject to the same criticism as corrugated sandwich from the viewpoint of corrosion inspection. The difference here is that, unlike the spotwelded corrugation assembly, the internal facings of the sheets and both surfaces of the core are resin coated prior to bonding, the epoxide resins used being excellent corrosion-resistant coatings.

In addition, the very nature of a honeycomb panel demands

* Chief of Engineering Research Division, A. V. Roe and Co., Ltd.

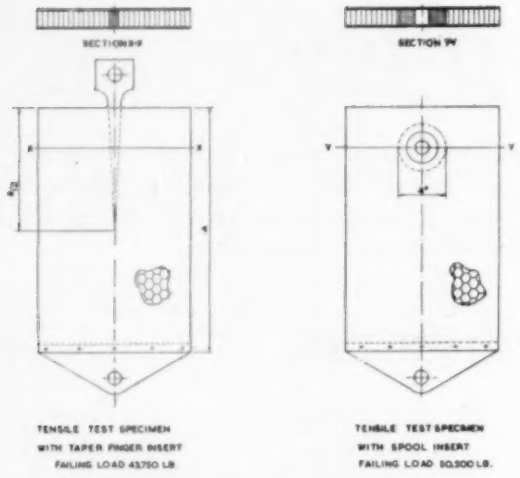


Fig. 3. Diffusion of a concentrated load into honeycomb sandwich.

side and end capping channels of Z-members, bonded into the assembly. This is a very effective method of sealing the structure to prevent internal condensation taking place.

Development Problems and Results

In 1952, there was some doubt about the answer to a question that has often been asked about cellular cores; what is the effect of altitude on a sealed honeycomb structure, and is there any risk of it bursting apart? The worst case to assume here is that sea-level atmospheric pressure of 14.7 p.s.i. is sealed within the cells of an assembly. In the limit, this will then become the differential pressure across the sandwich as height is gained right up to the altitudes required for satellites and space vehicles.

Tests were carried out by pressurizing the internal cells of edge-sealed circular samples. Pressure differentials of up to 150 p.s.i., or 10 atmospheres, were attained, thus giving a safety factor of 10 in the most unfavourable circumstances.

Honeycomb-stabilized sandwich is essentially a distributed structure for distributed loads. The aircraft designer, however, is faced with many places where the loads are concentrated in small sections, and must be diffused into a distributed structure.

Various methods of diffusing concentrated loads into the honeycomb panel were tried and tested, including the circular

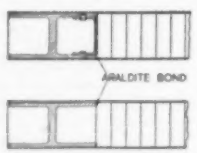


Fig. 4. Shear transfer from core to edge member.

spool type and tapered finger type shown in Fig. 3. Whereas the failing loads quoted apply solely to the specimens illustrated, it is interesting to note that two 18 s.w.g. skins 12 in. wide will fail in tension at the load that can be applied through a bonded 4-in. diameter insert. In no case was there an adhesive failure at the insert to skin bond line.

Another early development problem concerned the edge attachment of the honeycomb core, particularly where butting up to extruded members. Should the core be attached to a special shear-carrying member, involving extra weight and production time, or was the shear resistance and stiffness satisfactory without?

Detail testing was carried out on the type of specimen shown in Fig. 4. Typical core shear stress values were reached on the specimen without a shear attachment, with only a very small increase in shear deflection when compared with the fully edge-bonded specimen.

Many tests were done on panel jointing methods both in tension and compression. Typical arrangements are shown in Figs. 5 and 6. The former illustrates a spanwise type of wing panel joint, the edge extrusion being in magnesium alloy. Several specimens were tested and, from the failure points indicated on the diagram, it is evident that the bond areas have approximately the same strength as the magnesium section.

Fig. 6 shows the type of extrusion developed for a transport joint in a honeycomb fuselage structure. The object here is to avoid external bolt heads and radial drilling. The latter would involve the cocoa-tin lid type of assembly with all its undesirable features. The failures again indicated correct correlation between the bond area strength and the basic sections employed.

Other fundamentals established by the original development programme included the tolerances and limits that had to be applied, not only to the core material but also to the critical dimensions of extrusions and rolled sections required for internal and edge members. In conjunction with this investigation, the variation in adhesive shear strength with different bond-line thicknesses was established.

On the practical side, a comprehensive series of tests to

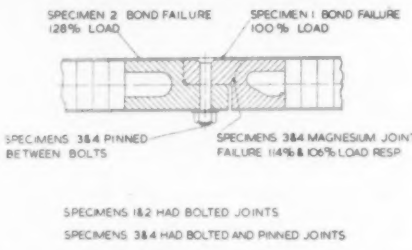

SPECIMEN 2 BOND FAILURE
128% LOAD
SPECIMEN 1 BOND FAILURE
100 % LOAD
SPECIMENS 3&4 PINNED
BETWEEN BOLTS
SPECIMENS 3&4 MAGNESIUM JOINT
FAILURE 114% & 106% LOAD RESP.
SPECIMENS 1&2 HAD BOLTED JOINTS
SPECIMENS 3&4 HAD BOLTED AND PINNED JOINTS

Fig. 5. Section through chordwise wing panel joint.

determine the techniques for field repairs was undertaken, using cold-setting adhesives to avoid the need for using complex curing cycles and hot curing fixtures.

During this development phase, the main body of the programme was centred on obtaining the basic data for strength and stiffness calculations on honeycomb-stabilized structures. To this end over 220 long- and short-column compression tests

Fig. 6. Fuselage joint.

were done, with different panel thicknesses, core depths and cell size variations. In addition, many tests to evaluate the core shear stiffness were made.

Over a period of two years, 1952-54, the background of information required was built up. It was learnt that metal-bonded honeycomb-stabilized sandwich structure could be joined together in a reliable manner; that dependable strength calculations could be based on the results of the test programmes carried out; and that the practical difficulties that face the detail designer could be met.

Application—The Avro 720 Rocket Interceptor

In 1954, aerodynamic investigation was made into a single-seat interceptor having an Armstrong Siddeley Screamer rocket motor as the main power unit and an Armstrong Siddeley Viper turbojet engine as an auxiliary unit.

These investigations showed that the tailless delta provided the optimum aerodynamic efficiency, giving a low wing loading, minimum drag and the required handling characteristics over the whole speed range up to about Mach 2. The flight-plan requirements were such that the kinetic heat input was low enough for aluminium alloy to be used as the structural material.

The aircraft configuration, shown in Figs. 7 and 8, was considered to be an ideal one for the application of honeycomb sandwich construction. Despite the requirement for a normal acceleration loading of 8g, and a root t/c of 0.04, the low-aspect-ratio delta planform gave a panel structural index figure low enough to ensure that honeycomb-stabilized sandwich would provide a high structural efficiency.

The fuselage fuel and oxidant requirements were such that the drag could only be kept low enough by providing the smallest possible envelope around the tank diameters. Here the honeycomb fuselage structure scores heavily, by reducing the depth required by former-stabilized structures (Fig. 9).

At the time, little was known about the fatigue resistance of honeycomb-bonded structure, but low-stress-level fatigue life was not an important consideration in this case in view of the nature of the duties and the high load factor involved. It was also known from other work that the fatigue life of a

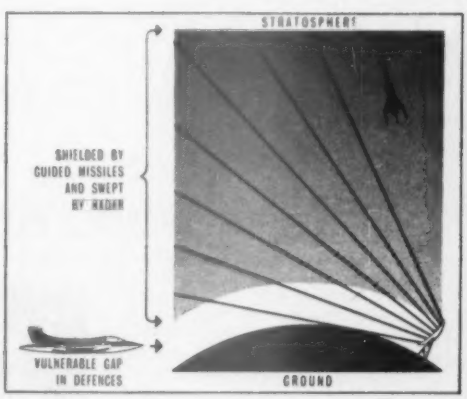
(*Continued on page 285*)

"The NA.39 is ahead" *

The most modern and advanced techniques in design and production have ensured that Great Britain now has the finest aircraft for the special role it has to perform—and on time.

Of this aircraft the Ministry of Defence has stated:

* *"In the low-level strike role, the NA.39 is ahead of any other aircraft in the world."*



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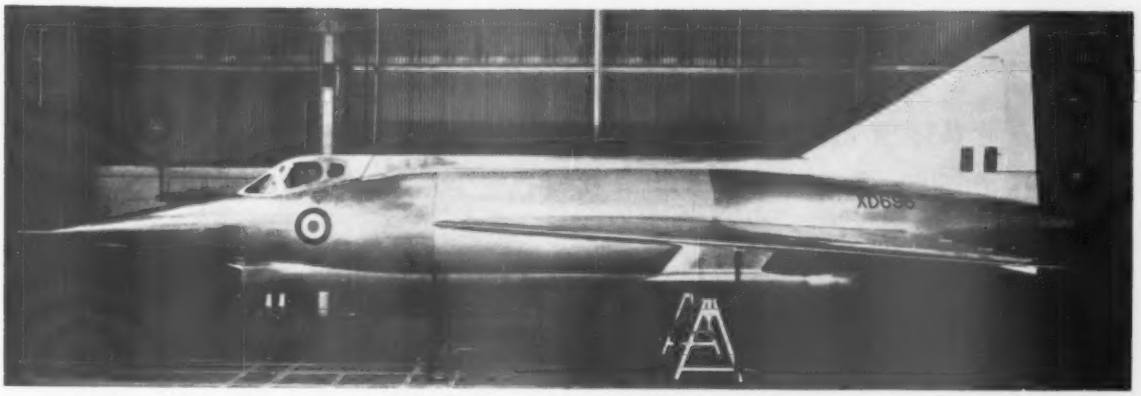

Fig. 7. The Avro Type 720 rocket interceptor prototype.

(*Continued from page 284*)

bonded structure was generally somewhat better than that for other types of structure.

Fig. 10 shows the cross-section of the torsion box, and also the Warren-girder type of ribs employed. These ribs were built up during the panel and web assembly sequence, using exterior strickle boards to locate the aerofoil surface accurately. The honeycomb panels, forming the bending-resistant material therefore ran from tip to tip, the aftermost panel being 2 ft. 3 in. wide by 26 ft. long.

Attachment to the fuselage was provided by finger-type shear pick-up brackets attached to each web under the fuselage wall line, and bolted to attachment points on the surface of the honeycomb. The spanwise joint between the panels was designed in a similar manner to that shown in Fig. 5, the correct joint line being achieved by machining edge members after curing the panels. Corrosion resistance of the magnesium extruded edge members was then provided by local treatment using protective resin compounds.

Control surface attachment points and the reaction points for the power-control unit anchorages were built into the rear panels of the torsion box, using the methods described previously and illustrated in Fig. 3. The control surfaces themselves, consisting of inner and outer elevon portions, were made of full depth honeycomb core running from top to bottom surface. The concentrated load at the control rod attachment points was taken on a taper machined I-section forging, bonded into the assembly during the honeycomb adhesive curing cycle.

The fuselage structure consisted of a central cylindrical portion, complicated only by a smaller re-entrant semi-cylindrical portion underneath to accommodate the turbojet engine. The honeycomb core was of the more flexible staggered type illustrated in Fig. 1, to ease the difficult internal lay-up required. Core depth was 0.9 in., with strong points inserted to distribute the liquid-oxygen tank reactions into the skins. The top half of the central portion was extended rearwards over the wing torsion-box structure, finger inserts being built in to take the reactions from the torsion-box web attachments.

Strength gradation and weight saving were achieved over the length of the structure by using longitudinal skinning on the outside of the honeycomb and circumferential skins of various gauges on the inside. Thus the internal and external skin joints were at right angles to each other, and the internal skins could be varied in gauge to suit the strength requirements.

The pressure cabin portion, attached to the front of this central structure, embodied a honeycomb rear pressure bulkhead, the lower portion of which carried the nose-wheel pick-up forgings. The honeycomb shell of the pressure cabin had tie points bonded in, forward of the cockpit rail, for mounting the instrument panel and pilot's controls.

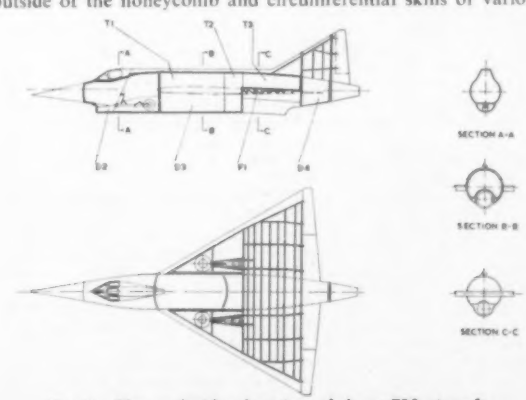

Fig. 8. Plan and side elevation of Avro 720 aircraft.

T1, Liquid oxygen tank. T2, Forward fuel tank. T3, Aft. fuel tank. D2, Pressure cabin. D3, Centre section. D4, Rear section. F1, Torsion box.

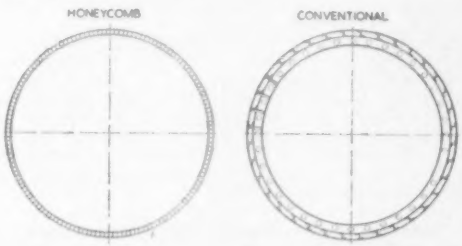

Fig. 9. Comparison between honeycomb and conventional fuselage structures.

Aft of the central portion, a circular tapered structure formed the rear portion which carried the mountings for the rocket motor, fin and dive-brake reaction points. A stainless steel extension to this portion, over the rocket efflux nozzle, completed the fuselage length.

The circumferential joints in the fuselage were made by bolting together two circular rolled extrusions, each bonded to the honeycomb portions, as described previously, using the cross-sections shown in Fig. 6.

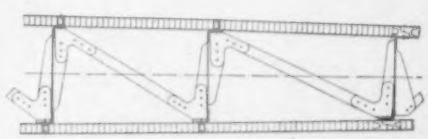

Fig. 10. Avro Type 720 torsion box structure.

During the design period, many *ad hoc* specimens were made. Tests were carried out with a view to ensuring that the production techniques employed would be both feasible in themselves and satisfactory from the point of view of the strength of the structure. The largest specimens in this category were a full-span torsion-box structure tested for stiffness and strength, and a representative centre-fuselage portion, tested under liquid-oxygen tank pressure.

To check the fatigue resistance of this type of structure, many types of test techniques were employed. These included the axial application of alternating tensile loads to bonded-lap shear joints, bonded-plus-riveted shear joints, and core material in shear and tension.

In addition, pulsating pressure was applied to box-type specimens, to subject typical wing panel structure to repeated chordwise bending stresses. Also jet efflux frequencies were simulated on a series of panels, using Fessenden oscillator equipment. These tests showed honeycomb bonded panels to have good fatigue resistance, and to be a superior form of

structure where acoustic fatigue conditions applied. The latter point was substantiated by American work in this field.

The full-scale test specimen programme for the aircraft included a complete static test structure and a pressure cabin fatigue specimen. The following points taken from the results attained are worthy of note in respect of the decision to employ honeycomb bonded structure for the majority of the components.

The static structural specimen was constructed before the first prototype, so that if any premature failure was found on test, the first prototype aircraft could be suitably modified. In actual fact, because of the later cancellation of the contract, only the high-speed flight case loading conditions were applied. These represented a normal acceleration factor of 8.0, plus a load safety factor of 1.5, at a Mach number of 1.52. The air loading was applied directly to the skin, through 350 separate adhesive patches. The general view of the structure in the test frame is shown in Fig. 11. The proof requirement of 75% of the fully factored load was met satisfactorily, and 100% load was applied without failure, no modification being necessary to achieve these figures.

Tests were carried out both with and without representative fuel tank pressures. On the sixth test the loading was carried beyond 100%, and failure of the starboard inboard elevon occurred at 110% by compressive collapse of the cantilever portion because of failure in tension of the Araldite bond. There is no doubt that this failure was aggravated by the fact that all the load was applied to the elevons by tension patches on one side of the surface only.

The pressure cabin was water-tank tested, using a differential pressure of 8 p.s.i. in conjunction with inertia and canopy suction loads. The specimen withstood over 36,000 cycles of load, before failure of the honeycomb occurred at the tie points across the fuselage designed for instrument panel and pilot's control attachment.

Constraint of these tie points caused local bending stresses in the honeycomb sandwich which led to failure of the adhesive bond. If development had proceeded, these constraints would have been removed by the introduction of sliding or swinging-link mountings for the attachments.

From checked weights, this structure was only 20% of the aircraft's all-up-weight. This represents a structure weight saving of about 15% on the best alternative type of structure that could have been employed.

Sandwich Development for Higher Temperatures

The fundamental choice to be made in the design of high-temperature-resistant structures is that of the material to be used. Any alloy has a useful temperature range, the upper limit of which is usually determined by the temperature at which re-crystallization or other metallurgical change in the structure of the alloy takes place. Table 1 lists the temperatures at which these changes take place, and the associated practical working temperature limits of a number of materials.

There are several other materials that could have been included in this list, the examples given covering a range of temperatures up to 1,000° C. The choice of a particular material for any given specification should be made with particular attention not only to the temperature requirement but also with respect to each of the following items:—

(1) Availability in the sizes required; (2) high ultimate stress; (3) reasonable ratio of proof to ultimate stress; (4) modulus of elasticity; (5) tangent modulus; (6) shear modulus; (7) ductility; (8) compression properties; (9) specific gravity; (10) creep strength; (11) fatigue strength; (12) notch sensitivity; (13) thermal conductivity; (14) thermal diffusivity; (15) coefficient of expansion; (16) resistance to corrosion; (17) brazing compatibility; and (18) cost.

TABLE 1

Material	Metallurgical Change Temp. or Upper Temp. Limit °C	Max. Short Time Operating Temp. °C
R.R. 58 light alloy	380	250
F.V. 520 stainless steel	550	450
6% Al. 4% Vd. Titanium alloy ..	550	450
Nimonic 90	950	800
0.5 : Ti Molybdenum alloy	1,350	1,000*

* N.B. Oxidation becomes rapid above 500° C, and external coating or cladding is necessary.

The choice of material may also be influenced by the structural configuration in which it is to be employed. If the decision to use a sandwich form of structure is taken, based on panel loading and structural efficiency considerations, a development programme on the lines that have already been discussed, plus the high-temperature implications, will be necessary.

All the materials listed in Table 1 can be joined together to form either corrugation sandwich or honeycomb stabilized sandwich structures. For corrugation sandwich, all are capable of being spotwelded but, as mentioned previously, it is prudent to employ this method of jointing only when the material is sufficiently corrosion resistant to avoid any deterioration of the structure over the period of life required.

If honeycomb sandwich is required, provided the necessary time and effort is spent on development of production techniques, all the materials referred to can be joined by bonding or brazing methods. Certain physical limitations exist, however, that must be recognized, and these are often encountered when it is desired to correlate the temperature requirements of the heat-treatment cycle of a material with the temperature cycles demanded by various brazing alloys.

As illustration of these points, some preliminary compression panel test results obtained prior to the design of the Avro supersonic bomber aircraft, Type 730, can be taken. Stainless-steel structure met the temperature requirement for this aircraft. After the properties of several types of stainless steel had been assessed the decision to use the precipitation hardening type F.V. 520 was taken as the best compromise between strength and thermal requirements, ease of fabrication, and with due consideration to the fact that the manufacturers were prepared to supply long coils of 39-in. width.

Stress calculations of structural efficiency for the estimated panel loading showed that a sandwich structure was desirable. Owing to the long range required at a high Mach number, fuel weight represented was an abnormally high percentage of the total weight, and a light structure was absolutely essential to the efficiency of this aircraft.

Simultaneously, various manufacturing techniques were being developed. For corrugated sandwich panels, methods of spot-welding, riveting, or combinations of the two were devised. For stainless-steel honeycomb sandwich, brazing processes using various brazing alloys grew from laboratory experiments to manufacturing processes for large aircraft components.

A series of short-column compression test specimens was prepared using the above methods. The cross-sections of the panels are shown in Fig. 12.

It will be seen that the 650° C. brazed honeycomb panel has the lowest efficiency when compared in this manner. This is due to the metallurgical reason that the brazing cycle using a quaternary-type alloy could not be carried out at the transformation temperature of the material, i.e., 700° C., which would boil off the cadmium constituent of the brazing alloy. On the other hand, the 650° C. minimum brazing temperature required was higher than the optimum precipitation temperature of 550° C., and properties of the material would be reduced.

The alternative brazing process, using a ternary brazing alloy of silver copper and zinc, avoids the cadmium evaporation and can be carried out at the material transformation temperature of 700° C. It must be remembered, however, that on cooling

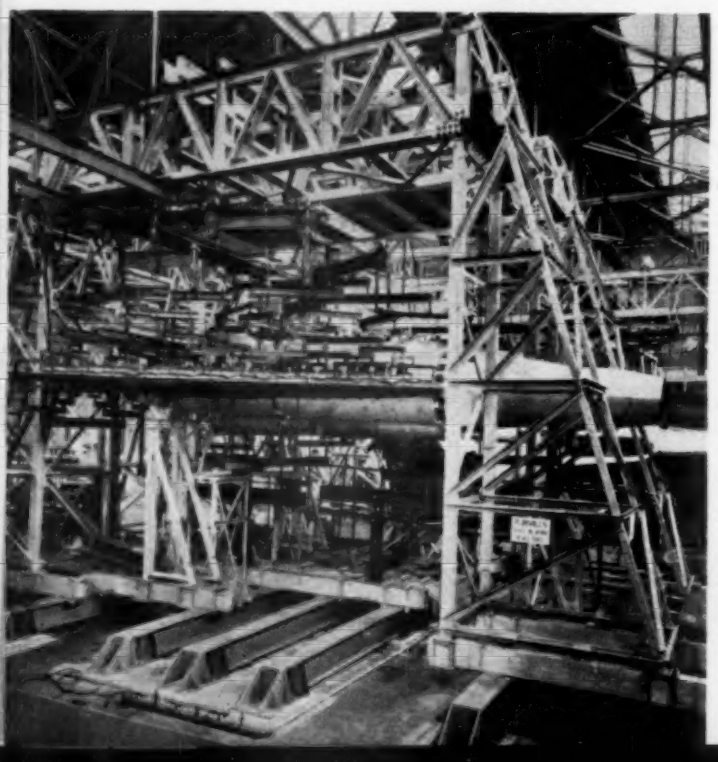

Fig. 11. Avro Type 720 in structural test frame.

THE STRENGTH & EFFICIENCY OF STAINLESS STEEL COMPRESSION PANELS

		RELATIVE SPECIFIC EFFICIENCY
A	ALL SPOTWELDED	100
B	700°C BRAZE (S.O. ALLOY, As, Cr, Zn.)	98.7
C	SPOT & ARGON SPOT WELDED	93.4
D	RIVETED & POP-RIVETED	86.8
E	980°C BRAZE (EP No. 3 Au.Cr. Cr. Br.)	69.4

Fig. 12. Relative efficiency of stainless steel panels.

from the transformation point, these types of stainless steel undergo an increase in length as the material becomes martensitic. The change of dimension for F.V. 520 due to this increase is 0.004 in. per inch, and in the case of long assemblies due allowance for this increase of length on cooling must be made. The final precipitation treatment at 550° C. must be carried out on the finished panels.

Any sandwich panel using honeycomb-core stabilization will tend to have a lower specific efficiency than one where the core material is contributing to the resistance of the load applied. However, it is interesting to note from these results how the higher temperature brazed honeycomb panel can compare with the different corrugated-core specimens.

The rivets used on these specimens give earlier inter-pitch buckling failures than the spotwelds. Also, the use of argon-arc welding, which was used for the blind attachment of the inside faces of one type of panel, gives a lower strength than the all-spotwelded samples. This arises from the fact that the heat-affected zone of the panel is of much larger diameter when arc-welded than it is when spotwelded. Hence, the most efficient panel structure, when considered from the point of view of specific end-load capacity alone, is the all-spotwelded sandwich, using corrugation and not the honeycomb core.

These results, in conjunction with those of other tests, determined that the mainplane torsion box of the supersonic bomber would be of multi-web design, using tip-to-tip planks of all-spotwelded F.V. 520 corrugated stainless-steel sandwich to resist the end load from bending. Where more isotropic properties were required, on the leading- and trailing-edge structure, stainless-steel honeycomb structure would be employed, either in the form of constant-thickness panels, or employing machined core for the full depth of the section where the thickness required it.

The fuselage structure presented practical difficulties from the viewpoint of using either form of sandwich construction and the more orthodox close-pitch stringer/skin combination was decided upon. Corrugation sandwich does not lend itself to double-curvature panels, and the production problems involved in manufacturing extremely large cylindrical structures in brazed honeycomb were formidable.

Extension of the work into the realms of even higher temperatures might well be termed "thermagineering." When thermal stress-resistant structures are required for projects, though the temperatures at the boundary layer may be formidably high, there are several ways in which sandwich structure can be employed with advantage.

Saturated, insulated, or liquid-cooled structures can be used. The time-temperature cycle for a given specified rôle, when studied in conjunction with mass and thermal lag of the structural arrangement, will indicate which approach is desirable.

Saturated structures are those which can withstand the required heat input for the necessary time without exceeding the limiting design temperature. The thermal gradients, causing thermal stresses, must be low with respect to the rate of heat input required, or thermal stress buckling may occur. Whilst the stabilizing core of sandwich structure is the major factor in resisting both long- and short-wave buckling, when heat is applied to one side of a sandwich panel the differential temperature between the outer and inner skins of the sandwich can in the extreme cause thermal buckling.

Various expedients may be adopted to reduce the temperature differential. Fig. 13 (a) shows sandwich panels with perforated outer skins, which could be used as inlets on the boundary-layer suction principle, drawing the hot boundary layer itself into the sandwich, thus ensuring that both skins are kept at reasonably equal temperatures.

Insulation on the inside of the sandwich, Fig. 13 (b), is another method of keeping an even temperature distribution—in this case by reducing the radiation and conduction of heat to the inside of the structure.

Insulation on the outside of the sandwich enables the structure to pass through short-time peak heat-input rates which, without this thermal lagging, would cause temperature rises greater than those that the structure will withstand. In certain conditions, the losses on the thermal roundabouts may be greater than the gains on the structural swings when using this type of insulation, however.

It must be remembered that the heat input is by boundary-layer conduction and without exterior lagging the skin temperature is reduced by external radiation. The presence of an external insulant reduces this radiation cooling factor, and under particular thermal circumstances higher average structural temperature may result.

The application of external insulants to high-speed structures is fraught with difficulties. The choice of insulants can vary from glass-wool or Refrasil to hard silicon-impregnated asbestos felts. In all cases, from the erosion and aerodynamic contour aspects it seems preferable to have a thin metal external skin.

A possible but not wholly satisfactory arrangement which might provide a basis for something more desirable is shown in Fig. 13 (c). The silicon asbestos-felt strips are attached to the sandwich structure by rivets dissociated from those which attach the outer skinning, thus avoiding a direct heat-conduction path from the boundary layer to the structure.

Liquid cooling or, alternatively, sweat cooling is another method that appears to have possibilities in connection with sandwich structure. Honeycomb would seem to be less suitable than corrugation sandwich for this purpose, in so far as small holes required in the foil webs for assembly purposes would have to be increased in size to reduce flow resistance and avoid clogging.

Using corrugation + sandwich in conjunction with liquid cooling, it would be uneconomical from the weight standpoint to fill the whole sandwich with coolant. A double corrugation sandwich, which would cut the liquid content down to about 15% of the whole volume, is shown in Fig. 13 (d). The upper corrugation size would be proportioned to suit the liquid flow rate required. Sweat cooling can be applied to the latter arrangement by using porous metal for the external skin.

Conclusions

We have seen how stabilized sandwich structure in light alloys was developed to a practical state which met the theoretical requirements, and was introduced as a working concept to the design of an advanced rocket-powered aircraft. The venture was fully justified by the major structural test results and the low structure weight percentage achieved.

Further logical development, using higher temperature-resistant material in the form of stainless steel, established the type of structure required for a long-range supersonic bomber. Several yet higher temperature-resistant materials suitable for future use in sandwich structures have been described, and possible structural arrangements for limiting the structural temperatures under more adverse conditions discussed.

Many of the practical disadvantages of using sandwich structure in certain conditions have been ventilated, and in conclusion it must be stated that sandwich is in no sense a structural universal panacea. It can, however, offer decided advantages when used as an engineering answer to specific requirements.

There is much work yet to be done in the field, particularly where the more exotic high-temperature materials are concerned. Processes for fabrication and methods of panel assembly and load diffusion will all need further sophistication to meet extremes of operating temperature, reduce thermal stresses and, above all, to reduce the structural weight required to carry payload and equipment into space.

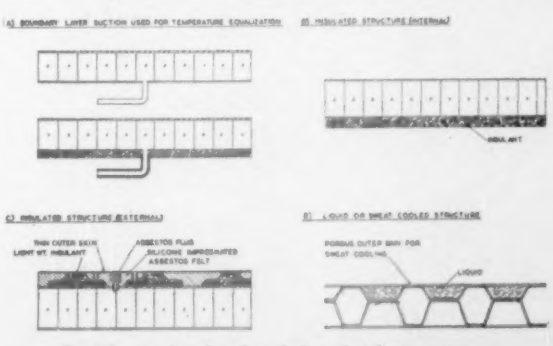
A) BOUNDARY LAYER SUCTION USED FOR TEMPERATURE EQUALIZATION
B) INSULATED STRUCTURE (INTERNAL)
INSULANT
C) INSULATED STRUCTURE (EXTERNAL)
THIN OUTER SKIN
LIGHT WT. INSULANT
ASBESTOS PLUS SILICONE IMPREGNATED ASBESTOS FELT
D) LIQUID OR SWEAT COOLED STRUCTURE
POROUS OUTER SKIN FOR SWEAT COOLING
LIQUID

Fig. 13. Insulated and cooled sandwich structure.

Materials and Processes . . . .

2 Production Problems with a New Type

By T. Bancroft, O.B.E.*

IN AUGUST, 1955, the Blackburn Aircraft Company received an order for the manufacture of a number of prototypes of a strike aircraft to Specification NA.39. At that time, the company's production facilities were fully occupied in producing Beverley aircraft.

The design of the Beverley was such that it enabled conventional machine tools and equipment to be used and apart from special long-bed, spar milling machines, portable milling and sawing machines, etc., little new production equipment had been necessary for it.

The size of the Beverley—it was the biggest aircraft in production in the country at that time—did pose problems, particularly in connection with jig design and component handling. The solutions of these problems and the general experience gained on the Beverley transports could, however, be of little assistance on a small aircraft such as the NA.39.

This implied a swing over from one extreme to the other, from a large conventional aircraft to a small sophisticated machine of advanced and in some respects futuristic design, embodying the complications normal to a deck-landing aircraft. In view of this, doubt was expressed in certain quarters as to the Blackburn company's ability to effect the transition from Beverley to NA.39—to produce and fly a prototype in April, 1958, i.e., within 33 months. The extension of this period by six months, to October, 1958, was suggested, but the company confirmed the April, 1958, flight date as realistic and continued to do so on the numerous occasions this date was queried.

At this time, little was known in the production office or works of any new manufacturing problems arising. But they were aware that wing skins with integral span and chordwise stiffeners, as well as contoured inner and outer surfaces, were to be made.

The design department co-operated by supplying advance information and advised that the work piece for the wing panels (eight per set) would have to be 5 ft. by 15 ft. by 2 in. thick. To obtain a machine tool to deal with these, emerged as an item of extreme urgency. Nothing suitable was being offered by British machine tool makers and the M.o.S. Equipment Pool could not help other than advise us of the Wing Panel Contouring Machine sponsored by the Ministry.

Particulars of this machine were obtained but these made it clear that it did not lend itself to our design, in that it catered for straight-line spanwise cutting only. Furthermore it was in the early stages of assembly and was unlikely to be available in time—in fact it did not become available until 2-3 years later.

We were, therefore, left with the possibility of buying a suitable machine tool from America. Whilst machines of the type needed were being used in the United States, protracted delivery dates ruling at the time were unacceptable and the cost prohibitive.

This situation had to be solved from the firm's domestic resources. A specification was laid down by our production office in the light of known design information; and a scale model of the proposed machine was built by our plant department, which would produce a panel machined to the final contours. At this stage it was decided to machine the panels flat and form after machining and before precipitation heat treatment.

The design and manufacture of a full-scale machine to take a work piece 18 ft. 9 in. by 8 ft., with cam-bar controlled hydraulic tracing gear and suitable for operation by semi-skilled operators, was put in hand with a target completion date of nine months. The bed-plate area decided upon was 22 ft. 9 in. by 8 ft.

Making such a machine foundation in conventional cast-iron sections, involving pattern making, casting, machining and scraping to the fine limits necessary, would obviously take too long. Therefore, the bed was fabricated to wide limits from standard rolled steel joists.

The top surface was fitted with 20 transverse light-alloy sections 8 ft. by 6 in. by 1½ in. to form a platform on which to mount the work piece. After fitting the 50-h.p., 2,850-r.p.m., Onsrud cutting head and the hydraulic control gear, a precision cam bar was installed and by taking a series of 4-in. wide cuts the platform was levelled to acceptable limits—0.003 in. over the full working area of 144 sq. ft.

The machine was complete in its final form within 10 months and was machining panels, employing semi-skilled labour, inside 12 months. Four production machines of this type are now working day and night.

Difficulties in the supply of the requisite slabs measuring 15 ft. by 5 ft. by 2 in., had arisen as no British supplier was equipped with a stretching machine capable of dealing with

(Continued on page 289)

* Production director, Blackburn Aircraft.

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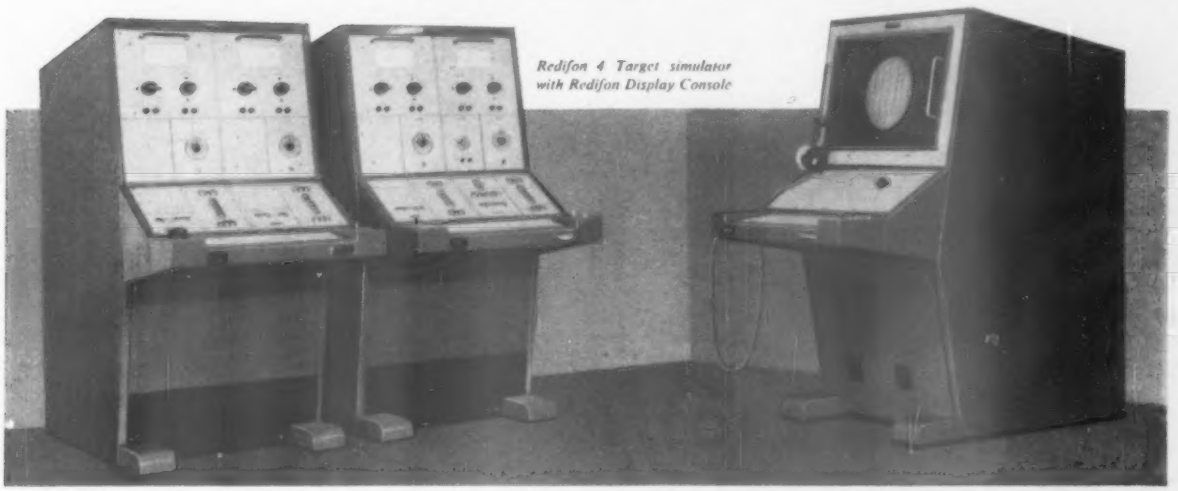

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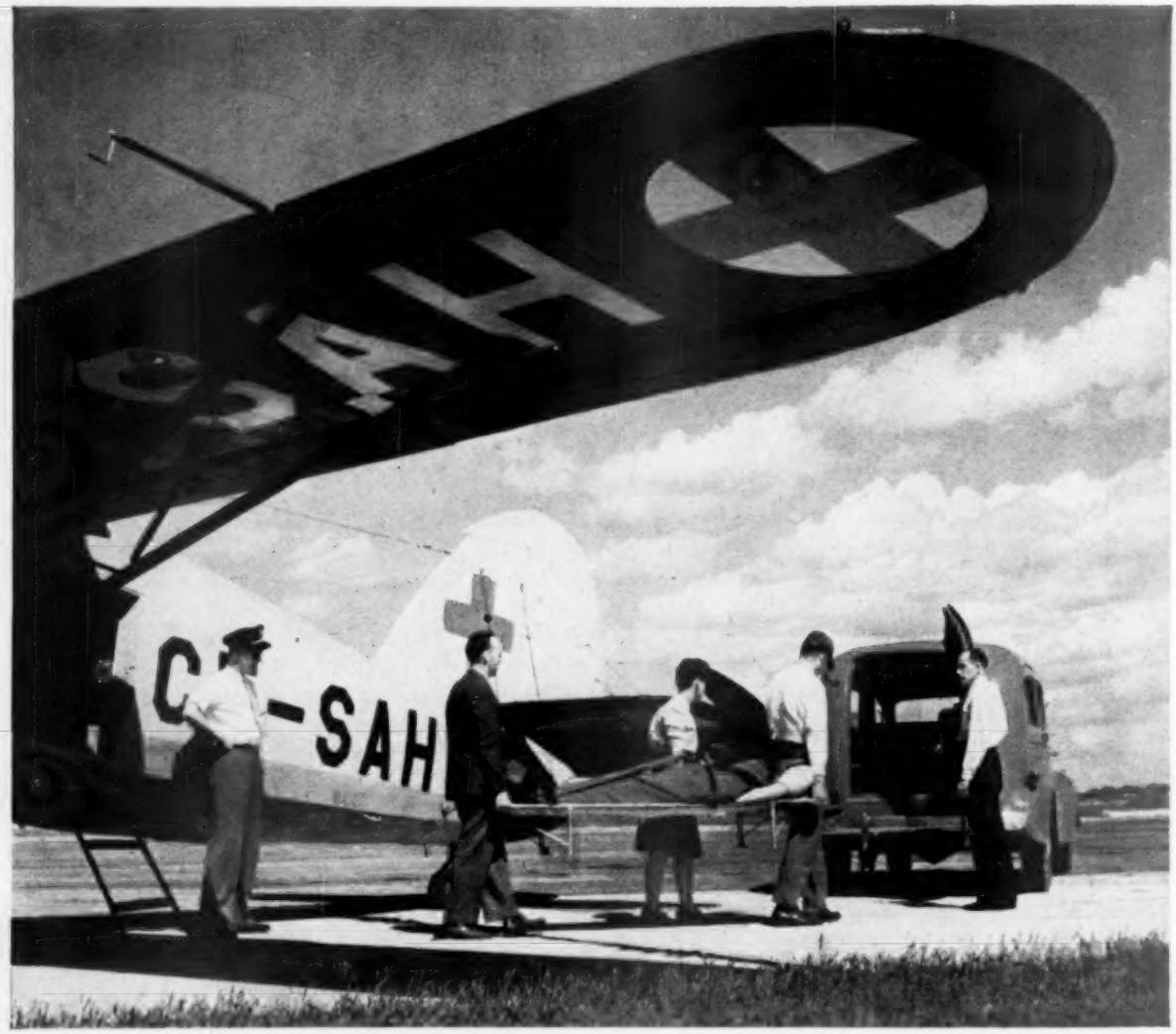

Saskatchewan's Air Ambulance Service provides transport for emergency medical cases in outlying farm districts. A patient is transferred to an ambulance on the way to a Regina hospital. Photograph by the National Film Board of Canada.

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(*Continued from page 288*)

our orders. Roller levelled slabs were offered in lieu of stretched material and one of these was set up for machining.

It was quickly apparent that the residual stresses in the roller-levelled materials were high; this was emphasized by the breaking of 12 0.5-in.-diameter holding-down bolts and the slab lifting 3 in. to 4 in. along one side. The fact that our light-alloy suppliers were not equipped to produce to modern design standards was stressed at appropriate levels and adequate British equipment has since been provided.

The merits of roller-levelled material had been suspect and inquiries had been made in the United States where the Kaiser Company had a stretching machine of the size and power needed. Immediate steps were taken and the Kaiser Company gave their full co-operation in meeting our order for stretched material and gave it the priority our programme demanded. The American material proved in every way satisfactory.

It was also necessary to obtain from the United States the inspection equipment (Vidigauge) for the checking of skin thickness. This varied in a non-uniform manner, from 0.2 in. to 0.8 in., and approximately 200 readings are taken on each panel during inspection.

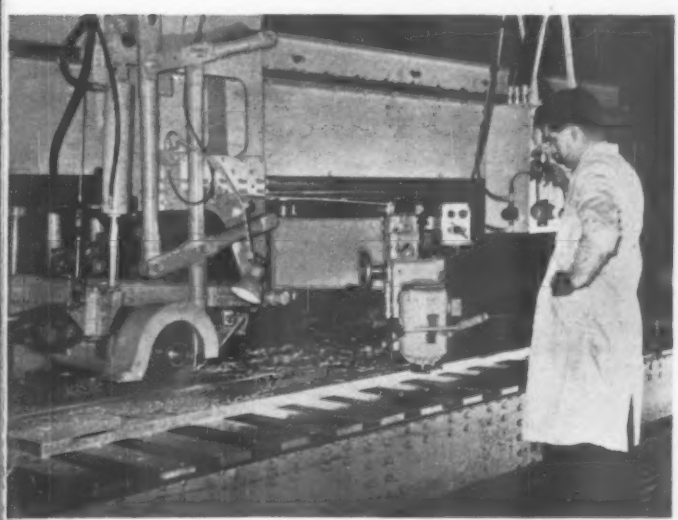
From the time it had been decided that the panels were to be formed after machining, our development department had been experimenting with various methods, including water bag, shot bed forming and shot blasting. Erratic variations in the skin thickness and wide differences in the depth of the spanwise stiffeners caused trouble and we were compelled to resort to straightforward top and bottom forming dies with packing strip inserts to suit the stiffeners as necessary.

By this method, the first set of panels was formed by progressive feeding through a short press made for the purpose. This was not a production proposition and later the press was extended to accept a full-length panel arranged in such a way that the load could be applied progressively from the thick end to the thin end of the panel or vice versa.

This feature gives the press flexibility of operation and assists considerably in the forming sequence. Plastics dies were used on the short press, but due to the difficulties and time taken to adjust for spring-back, the full-length dies were made in wood. If and when production demands, these will be copied in plastics.

By this time we were confident that what had been regarded as our major problem was solved. We were wrong.

A closer view of one of Blackburn's four-head millers.



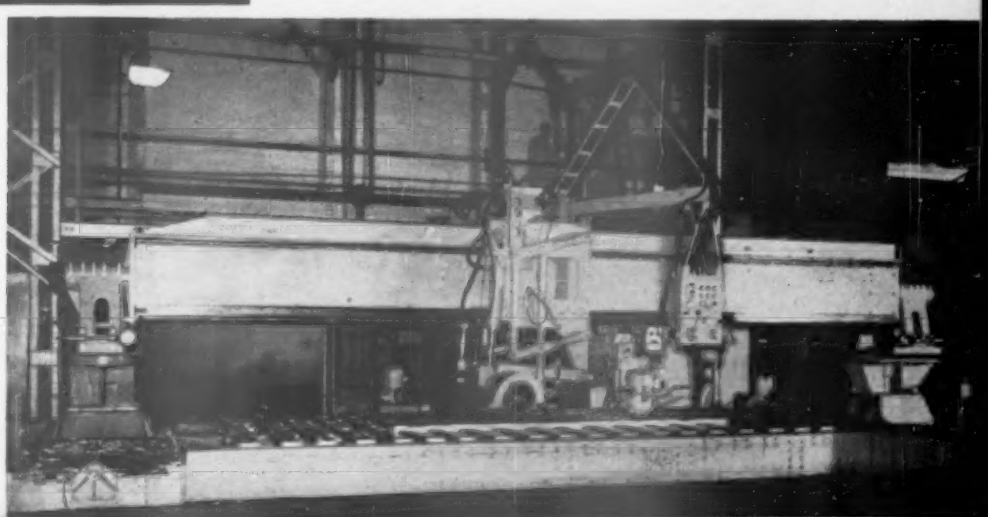
Problems with Steel

It came to light that a number of main structural components normally made in light alloy must be produced in 85/90 ton steel in order to carry the loads applied on an aircraft structure operating in high-turbulence/low-altitude conditions.

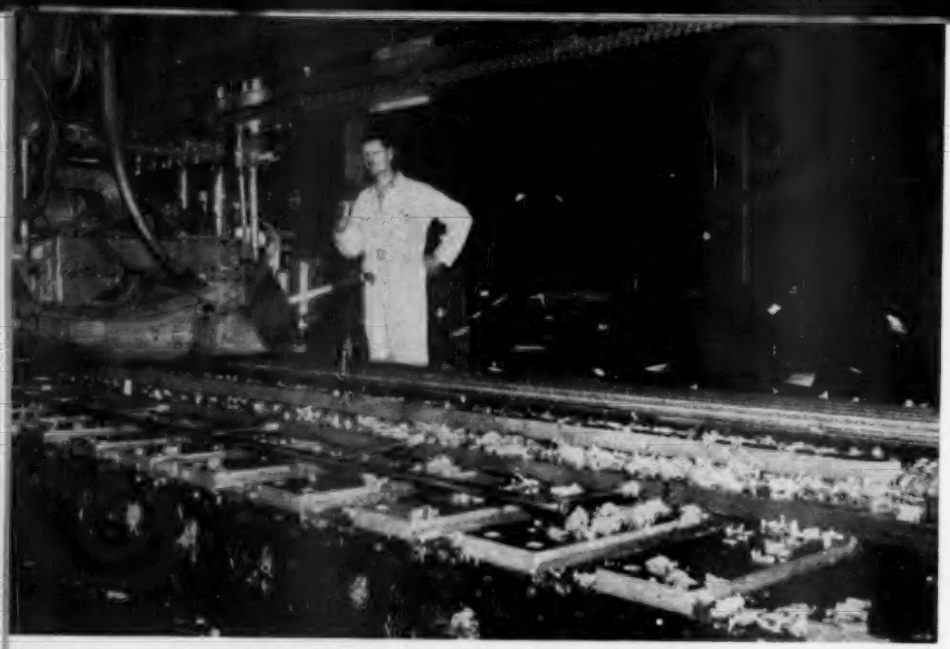
The outstanding example of some two dozen items affected, called for a steel (hand) forging weighing 25 cwt. to be machined down to approximately 311 lb. in a difficult configuration and to close limits. Only a small amount of metal removal could be done by barrel or face milling, the majority of the work being confined to end milling, using 1¼ in. dia. cutters. The nature of the design made copy milling from templates a *must*—which meant that the work could only be processed for large copying vertical single-spindle mills—we had one only of these.

The first one or two components were rough machined in the annealed condition—i.e., 60 tons and heat treated to 85/90 before final machining—but the severe distortion trouble encountered decided us to machine in the fully heat treated condition. This is now our standard practice.

As the full picture of the volume and complexity of steel machining became clear, it was evident we were facing a new situation so far as aircraft production in this country was concerned, and it was considered desirable that advantage should be taken of current techniques in the United States. The good offices of the then M.o.S., and the British Joint Services Mission, resulted in permission being given to three Blackburn representatives (one production, one plant machine



Above, the Blackburn beam miller skinning a wing "plank" prior to rough cutting. Right, an overall view of the beam miller.



Another view of the beam miller rough cutting a wing skin panel.

tool and one design) to visit the factories of 12 leading American aircraft companies.

They were briefed to investigate: (a) Machining of heavy high-tensile steel forgings; (b) special-purpose production machine tools; (c) the possibility of chemical etching or spark erosion of steel on a production basis; (d) the use of steel castings instead of forgings; (e) cutters and coolants used on H.T. steel; and (f) fabrication by welding, in particular flash butt welding.

At the plants visited a number of new and interesting developments were seen. Nothing material however was found which could be applied to our immediate difficulties on heavy steel fittings. In all cases, the American production teams hoped they would be able to avoid our type of product, but their design departments agreed that they saw no alternative if they themselves had to design to our specification.

We now had to face up to the fact that no alternative time-saving techniques had been found and that heavy vertical copying mills were the recognized machine tools for our work. The American companies had them—we had not.

It was now clear that we were again breaking new ground in producing components such as steel front and rear spar fittings, ribs, etc. We would also have to break new ground in machine tools and methods of machining and abandon the use of existing machine tools costing over £20,000, each driving one cutter of 1¼ in. dia., with one skilled operator per machine.

Our task, it was considered, called for a means of working four cutters simultaneously (two on each side of the work) with independent electric tracer control over an area of 4 ft. by 3 ft., and arranged to remove the maximum amount of metal at one setting with one semi-skilled operator working two cutters.

Time did not permit the design of special drives, gear boxes, tracing gear and the like and "bought off the shelf" units had to be found. Nothing suitable was found in the United Kingdom, but at the machine tool exhibition in Hanover, our plant engineer found existing German units, together with Austrian electric tracer equipment. These, with some modification, filled the bill.

M.o.S. had been approached for support in the manufacture and development of the machine and a specification and preliminary drawings submitted. Time was vital so we decided to go it alone in order to meet our programme and orders were placed with the Henschel Company in Germany, resulting in a prototype machine being put to work within nine months.

Teething troubles were few and minor and it was found that the advantages we had aimed to gain were achieved. A further six machines were ordered, one of which has been made by Thomas Green and Son, Ltd., a subsidiary of the Blackburn Company, who had previously made two of the four wing-panel milling machines.

Whilst, in effect, we now have seven machines with four heads each, we regard it as one machine with 28 heads, as all the units are mounted on a common gantry 160 ft. long by 10 ft. wide, with "T" slots running the full length, permitting sliding of the units as required. This feature provides capacity for the tracer-controlled cutting of a work piece 140 ft. by 3 ft. by 1 ft., in steel or titanium.

The advantages referred to previously by comparison with conventional machining include: (1) Absence of distortion by cutting both sides of the work simultaneously. (2) Increased cutter life due to the cutter working in the horizontal plane free from swarf and running in fresh coolant. (3) A reduction in the number of holding down fixtures required. (4) 40% less floor area necessary. (5) A reduction of 30% in the number of operators required. (6) A shorter manufacturing time cycle. (7) Saving in capital cost of machine tools.

Satisfactory progress has been made in the development of special-purpose machine tools, but this cannot be said of the development of special cutters, particularly end mills. The introduction of cutters capable of accepting the speeds and feeds offered by the machines in the cutting of steel is of vital importance. Development of cutters is continuing.

It is our opinion that advanced design calling for large components in steel or titanium will demand the introduction and development of multi-head machines on the lines we have followed at Brough.

The NA.39 design necessitated further new processes of a minor nature such as the machining, forming and welding—seam, spot and gas—of titanium, stainless steel and Nimonics. The chemical etching of light alloys, including magnesium is used extensively. Also the fabrication of plastics transparencies is now being done in works departments. The introduction of these presented no real difficulties.

To summarize—we think we may claim that a design which at first sight was a production engineer's nightmare, is now just another aeroplane. We see no reason why, with the machines and equipment devised to meet the design, the manufacture of the NA.39 in production quantities should present any abnormal difficulties. The prototype NA.39 was flown to programme in April, 1958.

A hydraulic press used for forming wing skin contours, at Brough, as described in the text.

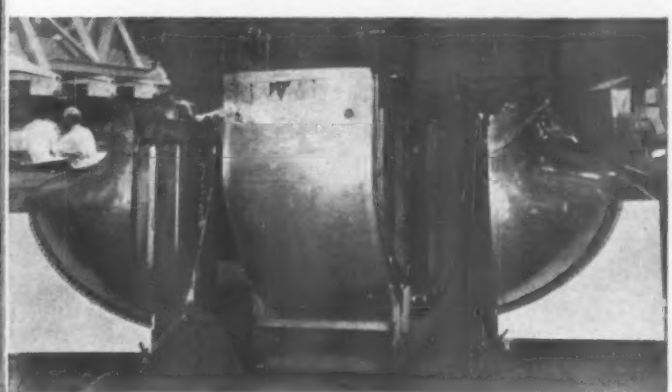
Materials and Processes . . .

3

Producing an Outsize Radome

NO aircraft spotter could fail to recognize the Fairey Gannet AEW.3, which appears to nestle on top of its large bulbous radome like a bird on an egg. Designed to give early radar warning of enemy attacks on the Fleet, this aircraft has a scanner which is considerably wider than its fuselage.

Manufacture of this complex radome makes an interesting study, although security regulations still prevent comprehensive details being given of its materials and construction. This unit is not only large; it also has a complicated reflex shape and



The male mould is made in three sections so that it can be withdrawn from the reflex-shaped radome at the end of the production cycle.

its production as a single unit represents a considerable feat on the part of the Fairey plastics division.

The radome is 12 ft. long, 8 ft. 6 in. wide and 4 ft. deep, and is made as a one-piece sandwich structure. Its inner and outer skins are of thermo-setting resin-bonded glass cloth and the core is a resin-impregnated glass-cloth honeycomb.

The studies which led to this radome began in 1956. A comparable radome had been used on the U.S. Skyraider, but this was made in halves which were then bonded together. In addition, the Skyraider unit was externally braced. The Fairey team aimed to produce a one-piece self-supporting radome, thereby providing complete uniformity of construction throughout the scanned area.

An important requirement in designing this equipment for the Gannet was that it should be capable of withstanding a temperature of 150° C. This was necessary because the jet exhaust of the aircraft passes over the upper surface of the radome. The general design requirements could be summarized as a need for sufficient structural strength, good electrical performance and the ability to withstand high temperatures.

The basic shape of the radome was dictated by antenna dimensions and the contours of the Gannet's fuselage. Its aerodynamic design demanded a compromise between the need for low drag and the effect of shape on electrical performance. As originally designed, it had a longer fairing at the rear and an overall length of 13 ft. 6 in., but this was changed to improve the radar performance and the rear fairing was shortened.

For an ideal electrical performance the thickness of a radome should be infinitely variable, but this is clearly not a practical proposition for production. A compromise employing two different thicknesses has been found to give satisfactory results. A double-thickness sandwich has been used where needed to give adequate structural strength.

Close limits on thickness are necessary; the design limit on skin thickness is ± 0.005 in. and on core thickness -0 to $+0.020$ in., giving a tolerance on overall thickness of 0.030 in. In production, however, an overall tolerance of 0.020 in. is now achieved.

Considerable efforts have been directed toward weight saving. Despite its size, the current production weight of the radome is only 230 lb. ± 5 lb.

The reflex shape at the top of the radome dictated the choice of a three-part male mould. This has been produced in aluminium alloy so that the mould heats rapidly and

A pressure of 12-13 p.s.i. is applied to the radome by the vacuum-bag technique during curing.

The mould is mounted on a fixture so that it can be raised, lowered or revolved to simplify application of the radome material. Here the mould is being lifted off the fixture prior to a curing cycle.

expands more than the radome material during the curing cycle, ensuring accurate shaping of the radome. On cooling, differential contraction simplifies removal of the mould.

An accurate airtight seal between the three mould sections was essential to prevent air leaks into the vacuum bag during the curing process when constant pressure must be applied. During curing the outer surface is covered with flexible sheeting which is attached at its edges to the base of the mould. Air is then evacuated from the space between the mould and the sheet so that atmospheric pressure forces the radome material onto the mould surface. In practice a pressure of 12-13 p.s.i. is maintained.

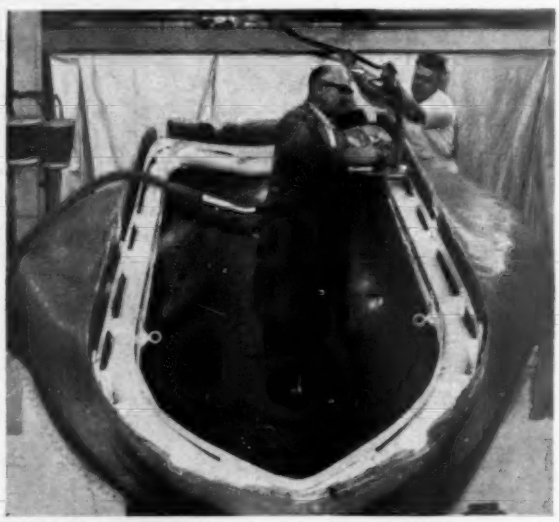
The inner resin-impregnated glass-cloth skin is applied to the mould in layers; resin content is controlled by passing each glass-cloth sheet through rollers. When sufficiently thick the honeycomb core is applied in sections, and then the outer skin.

Production is divided into several stages dictated by the radome's construction. Between each stage the material is cured under pressure in an oven; curing at 100° C. for one hour is necessary. It is impossible to over-cure the material at this temperature and some sections of the radome undergo repeated curing cycles.

The build-up of the radome is closely controlled, and the positions of all glass-cloth joints and sandwich core sections are specified. All production radomes must be identical and it is essential that identical materials and techniques should be used.

A quality-control test-piece is built as an integral extension of the radome and is tested to check that curing of the resin is satisfactory. Very consistent results have been achieved.

After final curing, the radome is removed from its mould, the edges are trimmed and attachment fittings are bolted on it. The final check for the radome is a test to ensure that its electrical properties are satisfactory.



Trimming the edge of the radome is one of the final stages in its production.

Electrical properties of radomes are checked before delivery to the Gannet production line.

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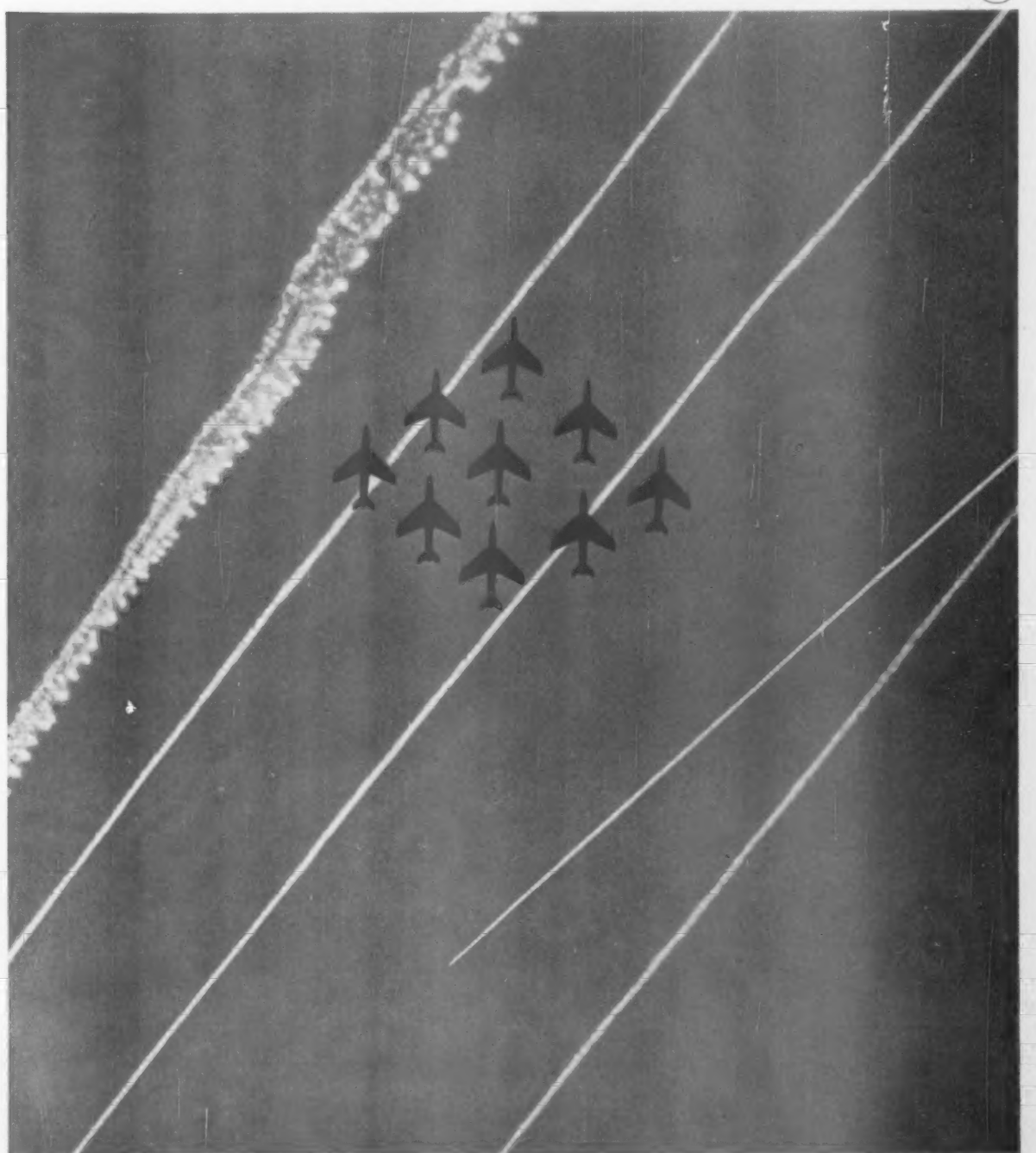

A Flight Photograph

DRAMATIC ANSWER TO THE AIR CARGO DILEMMA

Many air carriers, striving to answer perplexing questions presented by a growing air cargo industry, are facing a basic decision: should they convert outmoded piston engine passenger equipment and put it on to air cargo routes? Should they order proposed cargo jets with 100,000 lb. payloads? Should they wait for further turbo-fan evaluations before making their air cargo plane commitments?

Canadair's Forty Four, offers a simple, practical answer to these vital questions. It is an optimum-size, all-new, all-cargo turbo-prop airplane that, in terms of productivity, is vastly superior to converted piston engine equipment, and one that offers, in comparison with the big jets, a payload capacity that is not unrealistically high for profitable operations during the 1960's. Furthermore, the Forty Four suffers little or no operating penalties due to runway limitations, and there will be no community noise problems.

The Canadair Forty Four has a productivity two to three times that of converted piston aircraft, at the same cost per airplane mile, and has a profit potential that will quickly recover any losses on disposal of piston engine aircraft now being used or contemplated for cargo usage. On the other hand, the Forty Four with a payload capacity of 65,000 lbs. and low break-even point is ideally matched to the natural expansion of the cargo market and will begin immediately to operate at profitable load factors.

The Canadair Forty Four is flying now and is in production for the three largest all-cargo carriers in the United States, and can be introduced into existing fleets as early as January 1961.

The Canadair Forty Four can operate in and out of all airports presently used by four-engined piston-powered aircraft. For example, at such an important airport as Midway, in Chicago, with only 6400′ runways, the Forty Four can take off with 90% of its maximum payload and fly non-stop to San Francisco.

Sophisticated design features, including swing tail and integral cargo handling equipment, slash direct and indirect costs.

Step-by-step savings and economies inherent in the Canadair Forty Four, combined with its very attractive price, let precious capital dollars work for better return quicker than other "proposed" equipment.

Thus General Dynamics Corporation's Canadian subsidiary, Canadair, the specialist in air cargo, proposes the Forty Four as the answer to air cargo's biggest dilemma.

Principal Features of the Canadair Forty Four

1. Low prime cost—less than ⅔ the price of proposed jets.
2. Low operating costs—estimated at $1.30 per aircraft mile, and less than 4¢ per ton mile.
3. Right size for the 1960's—its present payload capacity is ideally matched to forecasted requirements.
4. No community noise problems—confirmed during present flight testing.
5. No airport or runway limitations—every major airport open to the Canadair Forty Four.
6. Growth potential—able to grow with the market.
7. Available for delivery in January 1961.

CANADAIR LIMITED, MONTREAL, CANADIAN SUBSIDIARY OF
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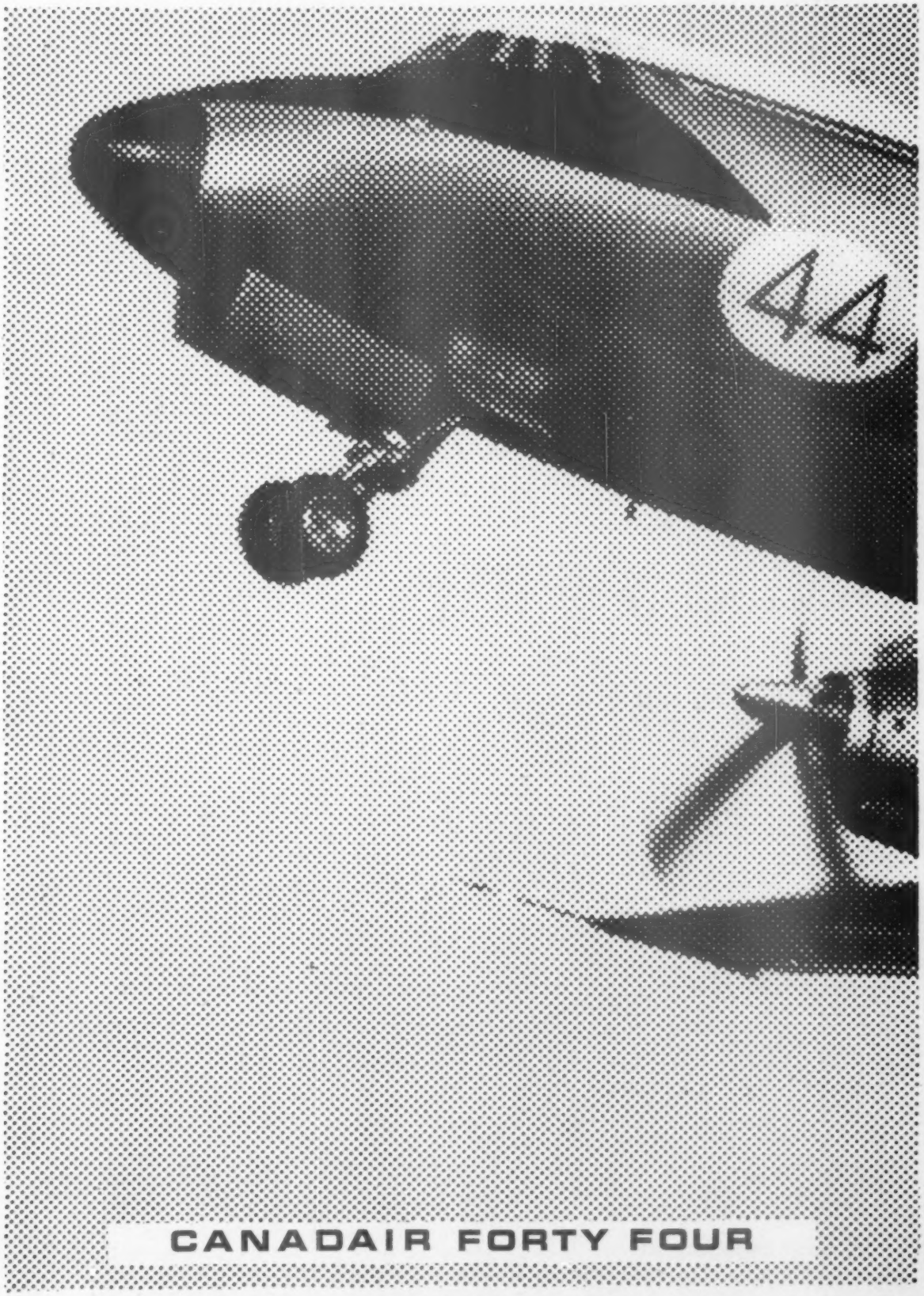
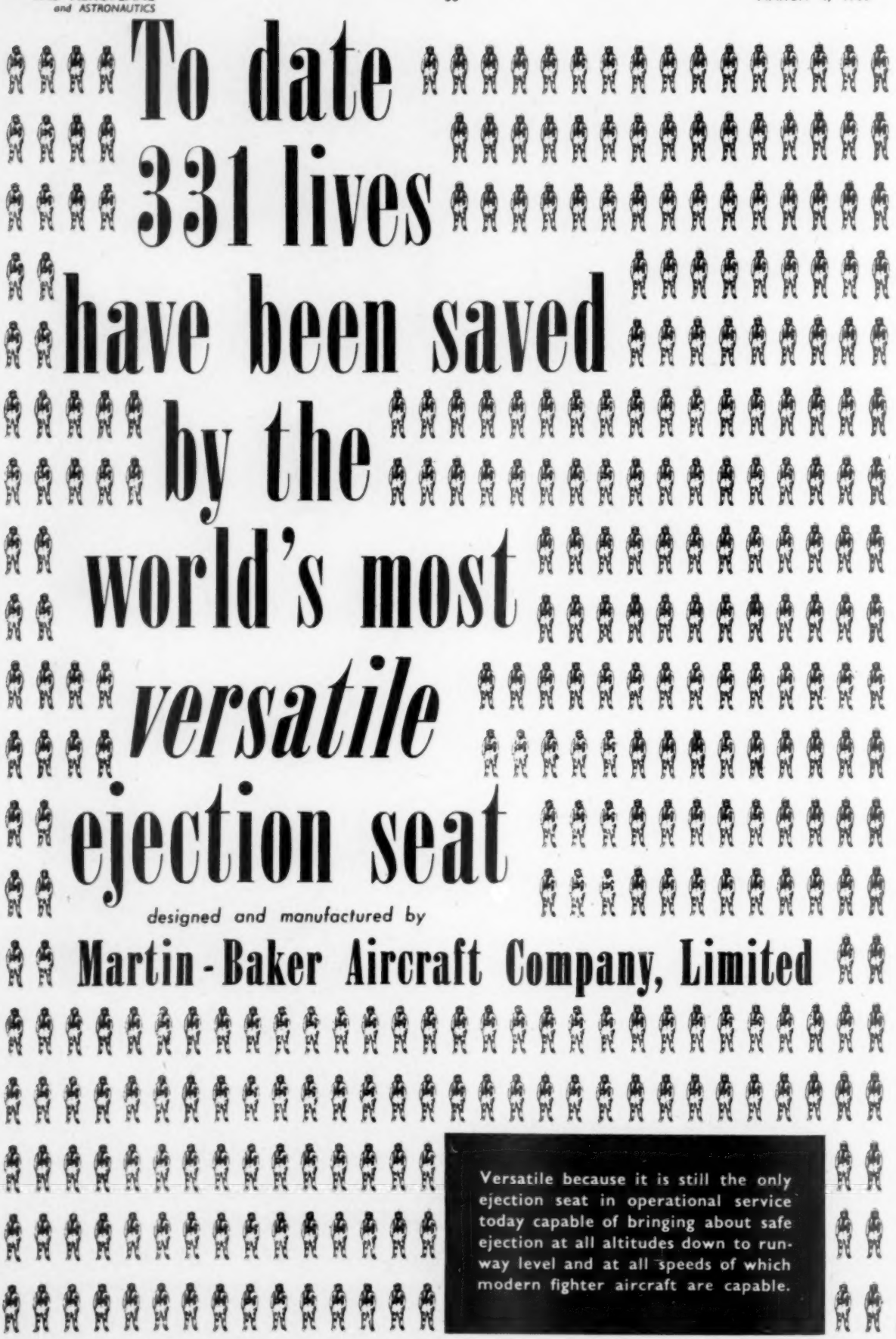


Please address enquiries to: J. H. DAVIS, European Representative of Canadair, Ltd., PRINCES HOUSE, 190 PICCADILLY, LONDON, W.1.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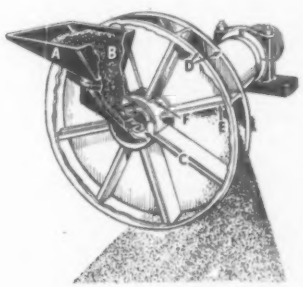
Materials and Processes . . . .

4 A New Surface Finisher

A "DIFFERENT" technique for obtaining an extremely high standard of surface finish on aircraft components was recently introduced by Short Brothers & Harland, Ltd., in their main machine shop at Belfast. An application of the Tilghman's Wheelabrator abrasive shot-blasting machine, this system supersedes surface finishing by hand using emery-mops with flexible drives. It is particularly attractive where large and awkward components are involved. The installation was evolved by Shorts and design details were discussed and finalized, with Tilghman's, Ltd., of Manchester, the company which produces the Wheelabrator.

With the Wheelabrator, metal can be removed at a uniform rate and surface finish of 60-80 micro-inches can be achieved with a consistent surface texture. The new machine has a large work cabinet 11 ft. long, 7 ft. wide and 6 ft. 3 in. high. This contains five eight-bladed impellers 19½ in. diameter and 2½ in. wide; three of these units discharge downwards and the remaining two vertically upwards.

The Wheelabrator impellers, individually driven by 25-b.h.p. motors, operate at a constant 2,200 r.p.m., and give an abrasive velocity of 10,150 ft./min. The maximum discharge rate of



ABRASIVE SYSTEM.—A hopper, A, feeds abrasive grit, B, to the centre of the impeller wheel, C. An adjustable gate, F, controls the direction of the abrasive which impinges on the impeller blade, E, and is hurled towards the working surface beneath at a speed of 10,150 ft./min. D indicates the side plates of the impeller wheel.

350 lb. of abrasive per head per minute gives an impact pressure of 75-80 p.s.i. at a firing distance of 15 in. Each wheel has an independent hopper feed, supplied by a main hopper above the main cabinet. Impeller wheels produce a fanshaped curtain of abrasive approximately 40 in. long and 4 in. wide.

Feed conveyors on each side of the main cabinet cater for spars and integral panels up to 50 ft. long by 4 ft. 6 in. wide. The loading height is 2 ft. 9 in. from the ground and the rubber-covered conveyor rollers are power driven.

The Wheelabrator can be operated by remote control. A master time switch can be set to switch off automatically all its motors, except those driving the dust arresters, after any period from five minutes to four hours.

A feed control to the conveyor is infinitely variable from 1 in. to 24 in. per minute in each direction. Large components can be cycled through the machine to individual requirements, the feed rate being dependent upon the surface finish required.

The abrasive grits used are No. 80 aluminium oxide (corundum) and a No. 80 grit mixture of silicon carbide and aluminium oxide. The mixture of silicon carbide and aluminium oxide does not last as long as plain aluminium oxide. Although a harder abrasive medium than aluminium oxide, silicon carbide does not stand up to the impact as well and is subject to greater breakdown.

As already mentioned, the surface roughness obtained is between 60 and 80 micro-inches (centre-line average). This is a considerable improvement; light-alloy components with machined surfaces normally have a maximum surface roughness of 110 micro-in. Consistent metal removal is obtained, and "notch" effect, where feed marks are apparent, is removed. Fatigue tests indicate that these surface finishes are superior to those obtained by hand finishing.

Although the introduction of the Wheelabrator was aimed primarily at eliminating hand finishing and polishing operations, before the machine is used certain blending operations must still be done by hand.

The machine can remove normal feed marks of not more than 12 micro-in. and can smooth out and improve component finish at a change of section on machined components. It will also improve finish in slots and cavities. But it cannot remove burrs raised on the edges of holes or steps and grooves of more than 0.005 in. caused by cutters, unless the components are fed through at a slower rate. To date this has not been considered practical.

Work ranging from 50 ft. spars to components 12 in. long can be dealt with. The former are fed through on rollers, while batches of smaller components are carried on special trays which prevent movement of the parts during surface finishing.

The rate at which metal is removed depends mainly on the freshness of the abrasive charge and on the feed rate through the machine. Other factors are the shape of the component and its position in relation to the abrasive discharge from the impeller wheels. Oblique approach of abrasive to the work surface is more effective than a direct vertical discharge. As much as 0.0015 in. to 0.002 in. of metal can be removed at a 3 in./min. feed rate; at a 24 in./min. feed rate metal removal is 0.00025 in.

The Wheelabrator is not restricted to abrasive finishing. It can also be used for shot peening of steel components and forgings. And sheet contouring can be effectively handled with little modification to the machine.

SHORT SET-UP.—This general view of the Short Wheelabrator installation shows components being fed into the machine for surface finishing: an automatic conveyor is used.

Materials and Processes . . . .

5 Materials on Show

BY drawing attention, in his opening speech, to the need to develop special materials suitable for airframe structures operating in high-speed high-temperature conditions, Dr. Barnes Wallis, chief of aeronautical research and development at Vickers-Armstrongs (Aircraft), started off the Engineering Materials and Design Exhibition* at Earls Court last week with emphasis on aeronautical engineering. He was speaking particularly of the temperature attained by the skin of a supersonic transport travelling at a speed of around Mach 4.5; the material for this, he said, must be able to maintain its strength and elasticity at temperatures in the region of 300°C.

Even if the final answer to his problem was not on show at the Exhibition, there was none the less a good deal to see that confirmed the strenuous efforts that are being made to meet these new problems. It was only to be expected, however, that, in an exhibition of this kind, the principal emphasis was not specifically directed on any particular industry. Even so, bearing in mind the particularly important part played by the aircraft and aero-engine industries in acting as a sort of catalyst in the development of new special-duty materials—that have since found application in many other fields—there was comparatively little to be seen of special aeronautical materials or design trends.

As part of the exhibition, however, a series of Conference sessions had been arranged and in some of the lectures reference was made to current applications of various materials in aircraft and missiles, and to the associated present-day problems. For instance, although not specifically discussed in relation to airframes, a good deal of information was available in a paper on weldable high-strength stainless steels by Mr. J. I. Morley of Firth-Vickers. This is a material that is becoming increasingly "noticed" for the new generations of supersonic aircraft; indeed, it has been reported that in the airframe structure of the Bristol 188 supersonic research craft, extensive use has been made of Firth-Vickers 520 stainless steel.

Two forms of the material were covered in Mr. Morley's lecture, F.V.520 (B) low-carbon martensitic steel available in all forms except sheet and strip; and F.V.520 (S) semi-austenitic stainless steel sheet material. Exceptionally good corrosion resistance is claimed for the 520 (B) material which can be welded; it is specially suitable for very highly stressed components; is resistant to stress corrosion cracking; and retains its mechanical strength at temperatures up to 450-500° C.

Of 520 (S) it is said that it is probably the most readily weldable of the semi-austenitic steels. This material has good forming properties, and also retains its mechanical strength characteristics at high service temperatures.

Magnesium was very much in evidence in the exhibition on the stand of the Magnesium Industry Council which embraced a wide variety of products from its large number of member-companies. It was also dealt with in a lecture by the Council's chairman, Mr. P. A. Fisher.

As he pointed out magnesium alloys are no newcomers to the aeronautical field, having been used extensively in airframes and aero-engines for at least a quarter of a century. More recently the development of new alloys, said Mr. Fisher, has enabled magnesium to keep up, at least to some extent, with the demands for higher strength at higher temperatures which modern high-performance aircraft construction requires.

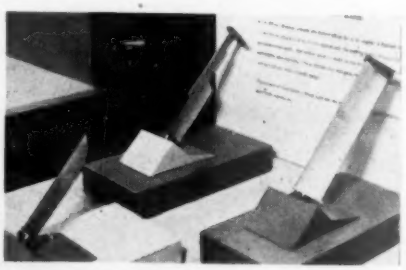
The influence of aeronautically, and astronautically, inspired development in other fields was underlined by Mr. V. E. Yarsley in a lecture on plastics materials for high temperatures. At the present time, he said, provision of materials for high-speed flight, and of electronic instruments which have to function at progressively increasing temperatures, are carrying the bulk of the research effort. For the future, Mr. Yarsley thought that for aircraft and space-craft plastics have a "tough assignment" and that it was likely that they would meet equally tough competition from ceramics and special metals.

Among the exhibitors on the 60-odd stands there were several familiar names in the aircraft industry. A few of them were showing items of specifically aeronautical interest, but the majority had chosen general displays more in keeping, perhaps, with the overall intention of the exhibition to interest designers by presenting as wide a variety as possible. On the Magnesium Industry Council stand, for example, was a bifurcated duct casting for the Rotodyne as an excellent example of this sort of application of the material; smaller items included a guided-missile component for Sperry, and a Rotax generator housing shell.

Wilmot Breeden displayed hollow nickel-chrome inlet guide vanes for the Sapphire. The Distillers Plastics Group had a whole range of exhibits including glass-reinforced laminates made with Cellobond polyester resins and Hycar oil seals. The I.C.I. stand included an interesting display of products from its Metals Division such as titanium and zirconium. Firth-Vickers Stainless Steels had a large display of the various uses to which this material can be put.

Among others showing their wares were:—

Bound Brook Bearings, Ltd.; Ferranti, Ltd.; Lake and Elliot, Ltd.; Langley Alloys, Ltd.; Lodge Plugs, Ltd.; Low Moor Alloy Steelworks, Ltd. and Low Moor Fine Steels, Ltd.; Macreadys Metal Co., Ltd.; The Manganese Bronze and Brass Co., Ltd.; Midland Silicones, Ltd.; The Morgan Crucible Co., Ltd.; Samuel Osborn and Co., Ltd.; Plastic Engineers, Ltd.; Sheepbridge Alloy Castings, Ltd.; Sheepbridge Stokes, Ltd.; Sintered Products, Ltd.; Small and Parkes, Ltd.; Thermo Plastics, Ltd.; The Torrington Co., Ltd.; Vickers, Ltd., and Henry Wiggin and Co., Ltd.



Right, hollow inlet guide vanes in nickel-chrome steel shown by Wilmot Breeden.

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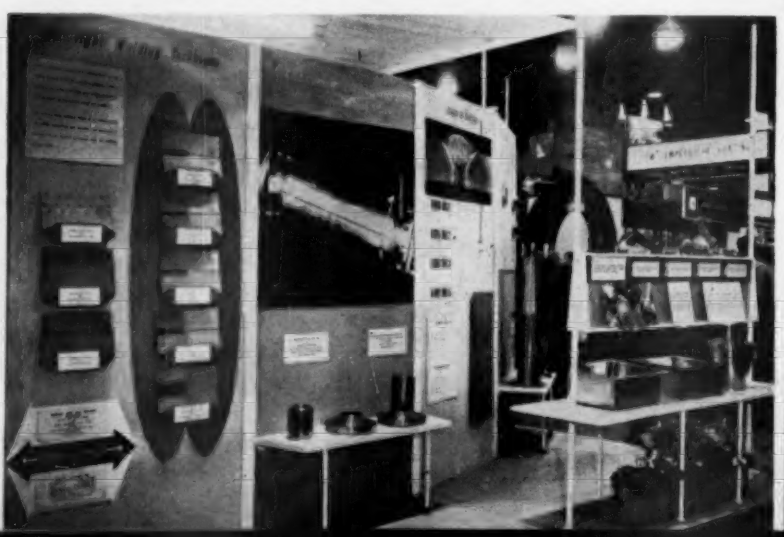


Left, a portion of the Firth-Vickers Stainless Steels stand. Below, a Rotodyne duct casting in magnesium alloy displayed by the Magnesium Industry Council.

Photographs copyright "The Aeroplane and Astronautics"

Personal Flying

HOW much does it cost to operate a medium-sized executive aeroplane in the U.K.? Some interesting figures have just been made available by Aero Enterprises (Boreham Wood), Ltd., for the Piaggio P.166, which is proving very popular for company use. Three of these aircraft are now registered for executive operations in this country, so the figures may be expected to be realistic.

Their starting point is the £37,220 basic price of a new and fully equipped P.166 delivered to the U.K., with 17½% duty paid. It is then assumed that £5,000 of radio equipment is installed, and a 15% allowance made for spares, adding £6,333. Depreciation to a residual value of 20% (£9,710) over eight years is assumed, together with a slightly pessimistic insurance premium of 4% of the £42,220 equipped cost.

With standard M.o.A. hangarage (£280 p.a.) and a pilot salary of £1,500, the fixed annual charges amount to £8,323. Variable costs include £6 an hour for fuel, computed from 75% of the standard U.K. price to allow for a small proportion of overseas flights, with their 2s. 6d. per gallon tax rebate. Landing charges, on an average sortie time of 1¼ hours, amount to £1.92 per hour, and engine and airscrew maintenance respectively for £2 and £0.33 per hour. Hourly airframe maintenance costs depend on utilization, and vary from £3.33 for 300 hours p.a. to £1.56 for 800 hours p.a.

Between these two extremes of utilization, it therefore costs in the region of £12,393-£17,760 to run a Piaggio P.166 in this country for a year. Equivalent costs per flying hour are £41.31 for 300 hr. p.a., reducing to £22.20 for 800 hr. annual utilization.

Managements will be more interested in seeing the meaning of these figures in familiar terms. In the five-passenger configuration, the P.166 costs, for 300, 500 or 800 hr. utilizations, 1s. 1d., 9d. or 7d. per passenger seat-mile. If its maximum capacity of seven passengers can be utilized to the full, corresponding costs will fall to 9d., 6d. and 5d. p.p.s.m. Cheaper, in fact, than a taxi.

PROSPECTING AT SNORING.—During a visit to the Fakenham Flying Group at Little Snoring on February 20, Gp. Capt. Richard Collard, M.P., secretary to the Aviation Committee of the House of Commons, flew the L.A. Prospector and also a Turbulent. He is seen here with the Earl of Bective and Mr. Ed McAully at Snoring. Some of the visiting aircraft are seen below.

* * *

Latest application of the P.166 is for photographic survey. With its very commodious cabin and ceiling of more than 26,000 ft., the P.166 is well suited for these duties, and Piaggio has prepared a camera installation for the German Hansaluftbild organization.

Little alteration is required to the cabin, which has an aperture on the port side behind the pilot for a twin vertical camera installation, and accommodation for a navigator/observer and an operator on the starboard side of the cabin.

Gliding Notes

by Dr. A. E. Slater

SIX free training courses at gliding clubs, lasting a fortnight each, are being offered by the Air League under the Robert Prefect Flying Scholarship scheme. They are open to young men and women who are under 21 on Mar. 31 but over 16 when the course commences, and who have neither qualified as aeroplane pilots nor reached "C" standard in gliding.

Candidates have to write an essay showing why they consider it as important today as it was in 1909 "to disseminate knowledge and spread information showing the vital importance to the British Empire of aerial supremacy, upon which its commerce, communications, defence and its very existence must largely depend," this being one of the objects for which the League was founded 51 years ago.

Essays have to be in by June 1, accompanied by a coupon from the magazine *Air Pictorial*, which gives full details. The Gliding Clubs providing the courses are the Derbyshire and Lancashire, London, Cornish, and the Scottish Gliding Union, and they will be held between Aug. 7 and Sept. 10.

* * *

AT two annual dinners, both held on Feb. 20, Cambridge University Gliding Club celebrated 25 years of existence and the London Gliding Club its 30th birthday. Being the only member who has turned up regularly for the full 30 years after joining it at the inaugural meeting on Feb. 20, 1930, I gave preference to the London Club's celebration, only to hear the president, John Furlong, tell the members that Dudley Hiscox joined it in 1929. There was no London Gliding Club in 1929; however, Dudley has indeed been in it a long time—he joined a few months after I did.

The chairman, Godfrey Lee, is another member of long standing, having joined just after he left school. Even after all these years, he pointed out in his speech there is still pioneer work to be done in exploiting new methods of soaring. There are waves in the jet stream, though a Meteor would be needed to tow sailplanes up to them from Dunstable. There is also dynamic soaring in the wind gradient near the ground—a sick-making procedure even if successful.

At the Cambridge dinner Fred Slingsby expressed his gratitude to the club for bringing him so much business. Being a university club, it has a large turnover, with a continual stream of ex-members fanning out to all parts of the World, where they either pep up any existing gliding club or start a new one. The result is a steady stream of orders from far countries, and a flourishing export market.

* * *

CAMPHILL'S first good wave of the year arrived on Sunday, February 21, and heights reached were 9,200 ft. by Graham Elsan in a Skylark 2, 8,500 ft. by Christopher Robinson in an Olympia, and 7,100 ft. by Ron Allen in a Prefect—all club machines. There was a marked "foehn wall," Walter Neumark writes. This term, as used on the Continent, describes the almost vertical face of the leeward boundary of the cloud over the mountain responsible for the waves; the cloud dissipates at this position because it has begun to descend on the leeward side of the mountain. The "wall" is therefore upwind of the first lee wave.

All three pilots were launched about 11.00 hrs. and came down an hour later, when the "foehn wall" had dissipated. Weather reports give an 11-knot wind from W. by N. at Manchester, and the chart shows a "col" approaching from the west of Ireland, so the state of the air must have been changing rapidly.

Neumark also writes that the arrangements for a race between a four-seater balloon and the Derbyshire and Lancashire Club's glider fleet, which he hoped to organize for Easter, have fallen through. The nearest thing to this in past history was a race between a balloon and a party of military cyclists in 1902, organized by the Rev. J. M. Bacon.

Correspondence

No Ships at L.A.P.

AS a reader of your paper for some 15 years, and being employed as a Customs Officer at London Airport, I feel I must enter into print in defence of myself and my colleagues, following the comments made by your correspondent on page 217 of the issue dated Feb. 19.

I am wholly concerned with examining air freight, and the statement that "Customs and Excise staff . . . may be dealing with ships' cargo one week and air cargo the next" is quite wrong. Most of the officers on the airport have been here several years, and in fact the minimum unit of appointment is one year. We don't get many ships unloading freight at London Airport.

As regards the expression "coastwise"—this applies to freight removed unexamined from one port (or airport) to another, and the revenue principles involved are the same regardless of how the goods are removed. It certainly doesn't mean that we insist on treating airfreight removed "coastwise" exactly as if it was being moved by sea.

Camberley, Surrey. "TIDE-WAITER."

The Best Twelve

I READ John Fricker's article on the 10 best books on flying (Dec. 25, 1959) with interest, and was pleased to note that, as is becoming the fashion in this sort of list, Pierre Clostermann's "The Big Show" was included. I was also pleased to note that "Wing Leader" by J. E. Johnson and "Reach for the Sky" by Brickhill, on Bader, were not.

The great books about air combat have action, technical detail, poetic vision, and compassion. They rush us into the sky to battle, then, in a series of painful revelations, they show us the pity of it all. We see the frailty of man, and, thereby, the courage of the few. We suffer the most painful revelation—all these men, enemy and friend, are the best and noblest of mankind. Is there any tragedy more heartbreaking and ultimate than these young pilots, the flower of the Earth's youth, tearing each other to pieces in exquisitely wrought machines, high in a lovely sky?

I do not care for the books about air combat which read like a report on a rugby match. I do not care to read a great fighter pilot condemn another pilot for screaming into the radio as he fell in flames. I do not care to read about another great fighter pilot who rushed to the telephone after release from prison camp and asked for a Spitfire. Surely, in maturity, there should come, to those who shot down brave men, a sense of final compassion?

These are some of the reasons I commend John Fricker's choice, and why I would like to mention two more to make a Best Twelve. Denis Barnham's compassionate "One Man's Window" and James Salter's marvellously beautiful and sad "The Hunters."

Sudbury, Mass., U.S.A. RAYMOND EULING.

Efficiency in Administration

I AM sorry that my article, "1959—The Turning Point," published on January 8, should have brought forth adverse comment from the Chief Public Relations Officer of B.E.A. (Feb. 12). The whole industry should, I think, work together as a unit in its competition with the rival surface forms of transport.

In doing this, however, it is well to keep in mind that much of the flying of the Independent Operators (inclusive tours and charters) is done at rates which approximate 2d. per seat mile. This is so competitive with surface travel that I believe, had controlled competition been permitted in British aviation on scheduled routes, we should have seen a greater proportion of travel done by air at this present time.

My article did not in fact mention the Corporations, B.E.A., or inefficiency. The statement at issue, "private enterprise with its more efficient administrative organization," implies that the Corporations are efficient (not inefficient). But the principle that private enterprise is more efficient appears to have been accepted by the electorate and politicians alike if the last election is any indication.

The profit margin yardstick can only be used if the capital involved is taken into account and I am unable to follow Mr. Simpson's argument that the Independent Airlines are better placed as regards payment of interest on the working capital. In order to survive, private enterprise must satisfy those who have provided capital by producing adequate rewards.

I believe Mr. Simpson would find if he investigated the numbers that it takes more ground personnel to operate a State airline than an Independent, in proportion to the operations achieved. Also he would find numerous ground staff appointments with no counterpart in an Independent airline as they had not been found necessary. By these yardsticks would I judge the efficiency of any enterprise.

The application of the Minister's recent statement, forecast in my article, that controlled competition may now be permitted, will be awaited by both the travelling public and the industry alike with great interest.

Woodford Green, Essex. R. H. AYERS.

The Potentialities of the Wankel

IT seems inevitable that the ultralight aeroplane will undergo a revolutionary change in the very near future. There is already in existence a lightweight engine, the rotary N.S.U. Wankel which weighs about a quarter of the equivalent internal combustion engine.

At present a water-cooled Wankel—Italian version—is driving a car in Italy; in Germany a 125 c.c. type is proving itself to be a happy solution of the—one time—engineer's dream. There are still difficult problems to be overcome in respect of efficient compression seals in the Wankel, which—sooner or later—will be solved and then, the "little devil" will step into the flying realm, and a "golden age" of small and safe aeroplanes will be realized.

A 125 c.c. rotary Wankel giving 20 h.p. and a couple of pounds only in weight—what a blessing it will be for a Turbulent or similar ultralight plane.

London, W.12. W. KWATERNIAK.

Roundabout

Plus ça Change . . .

A British aircraft designer friend, who went to Convair and is now working on manned satellites, writes so movingly of the changing pattern, that to savour fully this emotional moment I have put on my rhyming boots. Thus:

In outer space
There is no place
For Reynolds or for Mach,
We now compute on
Kepler and Newton
—And we're just as much in the dark.
(Kepler? An astronomer)

*

The Numbers Game. The business of bestowing endless serial numbers on variations of basic airliner types has now reached the point of total bewilderment for this columnist. When, for instance, I read that Tradair, of Southend, had bought two ex-Aer Lingus 707s, I mused "*707s* operating out of *Southend*? And by a small independent? Next thing the flying clubs will be buying them." And Aer Lingus, I thought, they had Viscounts. That's it! *Viscount* 707s. I read on—"Irish Air Lines are buying Boeing 720s." But surely they ordered 707s—*Boeing* 707s? What's that? The 720 *is* a 707? Then why do they . . . oh, well, never mind.

*

The Swings and the Roundabouts. And speaking of the 707—and who isn't—have you noticed the extraordinary number of ground starter vehicles which have been produced for it? Now Boeings themselves, probably trying desperately to squeeze a *little* profit out of the airliner business, have come out with their own version. Opens up a new line of thought, doesn't it? No money in building aircraft these days—O.K., let's make it on the ground equipment. And I've a suspicion that Boeings already have some sort of holding in that prospering company, Runway Extensions, Inc. Branches everywhere.

*

Scientists must not mix with **PEOPLE**

by Gwen

Industry Record

Airport Radar for Italy

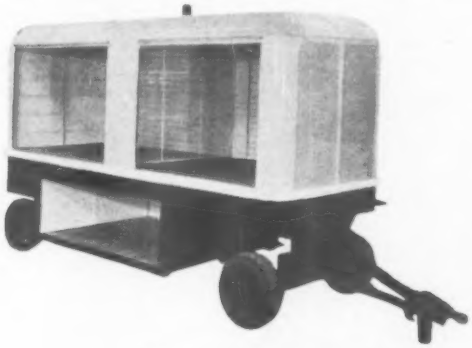
The Italian Government is to install a Marconi 50-cm. high-power radar, Type S.264A/H, together with two display systems (comprising 11 display units) and a microwave radar link, at Fiumicino Airport, Rome. The radar head will be generally similar to that at present being installed at London Airport, except that the Fiumicino installation is designed to provide additional high-level coverage.

Two display systems are being provided so that the radar can be used for short-range (40 miles) and long-range (160 miles) functions. Installed in different locations, the two display systems are to be connected by the microwave radar link. The contract, valued at approximately £177,000, brings the total number of Marconi 50-cm. radars sold to 29.

South African Decca

Field trials of a new type of Decca receiver were undertaken by the South African Council of Scientific and Industrial Research during November of last year. Held in the Transvaal to determine whether the receiver was capable of overcoming the local conditions of atmospheric noise, they showed that the probability of serious interruption of service by such noise is very small and is comparable with, or lower than, that normally expected from other causes.

The company is now prepared to provide a South African Decca chain and has appointed Brig. H. G. Willmott, C.B.E., S.A.A.F. (Retd.), as their special representative. Until his retirement a few years ago, Brig. Willmott was Chief of the South African Air Staff.



A one-ton capacity aircraft catering trailer for London Airport manufactured by Reliance Trucks Ltd., of Heckmondwike, Yorkshire. Designed to operate between the airport kitchens and the aircraft, it has two upper compartments for solid food containers and one lower compartment for liquids.

Miniaturized Flight Instruments

The U.S.A.F. Wright Air Development Center has awarded the American associates of Honeywell Controls, Ltd., a £62,500 contract for the development and design of an advanced miniaturized air data display instrument system. To be incorporated in the Center's integrated flight instrument panel for high-performance aircraft, it consists of two units providing a total of 14 different parameters of information.

In addition to the standard flight information provided by conventional air data displays the new Honeywell system incorporates a take-off monitor and terrain clearance display. The contract calls for six prototype systems.

Dust-free Packaging

Reynolds (Packaging), Ltd., have now constructed a dust-free air-conditioned room at their works at Barking, Essex. This facility enables the company to clean and seal such items as flexible and rigid pipe products for aircraft, guided missiles and test rigs, with particular reference to hose assemblies for aircraft hydraulic controls and high-pressure fuel systems; filtration equipment for aircraft and guided missiles; oxygen breathing equipment; electronic actuating gear; and fine instruments, particularly those related to guided weapons systems.

Electronic Review

Summarizing its member-companies achievements, The Electronic Engineering Association's publication "Annual Review of 1959," highlights a number of export orders for aeronautical equipment. And, although reported in these pages at the time of their announcement, it is interesting to look back on some of these contracts.

One, worth £7 million, for an extensive NATO early warning radar system is shared between the United Kingdom and France, the British company carrying the major responsibility. Another is for a radar defence system embodying new automatic electronic techniques which is being supplied to Sweden. The initial contracts for this latter system, worth £1,500,000, include a high-speed computor to solve many of the interception problems simultaneously.

Russia has figured more prominently as a customer than before. The Tu.104s on the London-Moscow service have been equipped with Decca, and it is interesting to remember that this contract was placed after the ICAO meeting rejecting the system in favour of VOR/DME. Russia has also purchased £100,000 worth of ILS equipment for use at Moscow Airport, and ordered a quantity of ILS/VOR airborne equipment from this country.

Ground equipment worth £250,000 has been supplied to Switzerland, Belgium,

High-strength Jointing

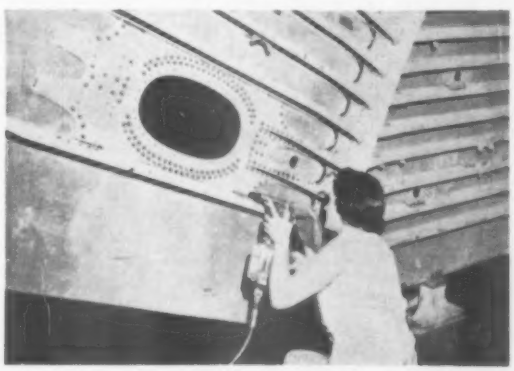
By arrangement with the Huck Manufacturing Co., of Detroit, Aviation Developments, Ltd., of London, are manufacturing and marketing the Huckbolt fastener in this country. Originally developed as a high-strength jointing medium for use on aircraft primary and secondary structures, the Huckbolt comprises a bolt with a head and three sets of grooves, and a locking collar.

The fastener is locked in place by means of a portable pneumatically or electro-hydraulically operated "pull-gun"; the placing and driving sequence being automatic. This sequence is undertaken at high speed, and American reports claim that Huckbolts can be installed in production at rates of up to 30 per minute over an extended period.

These reports compare this figure with the flat rate of 360 rivets per hour for two operators placing conventional rivets, highlighting the fact that the fastener's high driving speed and simplicity of operation are two of its most important factors.

Aviation Developments, Ltd., are first producing aircraft Huckbolts of $\frac{7}{16}$-in. and $\frac{1}{4}$-in. diameter in steel to specification S103 and then in aluminium-alloy to specification 24ST4. The use of 24ST4 means that users can now employ an aluminium-alloy of higher strength than alloys normally used for riveting, and thereby effect comparable joint strengths by using less fasteners. At a later date, aircraft Huckbolts of larger diameters will be produced.

The British-manufactured aircraft Huckbolts are being submitted to comprehensive strength tests and, although these tests are not yet complete, typical representative figures obtained to date indicate that the strength values will be 3,000 lb. in single shear and 2,500 lb. in tension for a $\frac{7}{16}$-in. nominal diameter, and 5,300 lb. and 4,900 lb. respectively for a $\frac{1}{4}$-in. nominal diameter. They have been used for a number of years in American aircraft production and large quantities are stated to be employed in the construction of the Boeing 707 and DC-8.



A pneumatically operated pull-gun being used to lock Huckbolt fasteners in a skin cut-out reinforcement assembly on a DC-8.

Industry Record . . . .

Holland, New Zealand and Ghana by one company which has also supplied VHF airborne units valued at approximately £80,000 to customers in eight countries.

One of the successes in aviation radar is an order for Swedish civil aviation of three 10-cm. surveillance radars for Stockholm, Gothenburg and Malmo. Similar radar is being installed at Maiqueta, Caracas. Other terminal radars have been supplied to, or are on order by, New Zealand, Denmark, Switzerland, Hong Kong, Belgium, Germany, France, India and South Africa.

Copies of the review are available from the Association at 11 Green Street, Mayfair, London, W.1, on request.

Dart Approved

The new K.L.G. high-energy igniter (Type KR-104) has been approved by Rolls-Royce as alternative to the existing igniters on all Dart turboprops. At present operated from a high-energy unit providing an output of 12 joules at 2 kV—but also suitable for use with high-energy units with lower outputs—the igniters also have full A.R.B. approval for all marks of Dart.

Aircraft Cleaner

Brent Chemical Products, Ltd., have introduced a new aircraft surface cleaner into their range of metal working chemicals for use in the aircraft industry.

This product, which is known as Ardrox No. 6015, is a detergent-type cleaner which may be diluted with up to 20 volumes of water and then applied to the aircraft surface, either by brush or preferably by pressurized spray, and then merely hosed down with water. The same material, when used as supplied or alternatively diluted with an equal volume of water, will also remove exhaust tracks or oil stains.

VC 10 Emergency Oxygen

Normalair, Ltd., is to provide the liquid oxygen storage equipment for the Vickers VC 10. A converter of 30-litre capacity is to be installed in each aircraft to supply the emergency oxygen system which is being incorporated to comply with the anticipated revisions to the Air Navigation Regulations. A feature of these Normalair converters is the automatic provision of a guaranteed crew reserve of oxygen regardless of passenger consumption.

Wing Commander D. B. Lord (left), Air Attaché designate, Copenhagen, and Gp. Capt. D. S. Wilson-McDonald (third left), Air Attaché designate, Stockholm, recently visited Bristol Siddeley Engines Ltd., at Bristol. They are seen here with Mr. J. Pollitt, the company's assistant chief test pilot, and Mr. J. Milner of the Aero Sales Department.

Aviation Calendar

March 4

Cheltenham.—The British Institution of Radio Engineers South Midlands Section lecture, "The Use of Radio Aids in the Control of Modern Transport Aircraft," by K. Fearnside, at the North Gloucestershire Technical College, at 19.00 hrs.

London.—R.Ae.S. Rotorcraft Section lecture, "British Research on Aerodynamics of Powered Lift Systems," by J. Williams, in the Library, 4 Hamilton Place, W.1, at 18.00 hrs.

March 5

London.—British Interplanetary Society Symposium, "The Exploration of the Moon," in the Lancaster Room, Caxton Hall, S.W.1, at 14.30 hrs.

March 7

Amesbury.—R.Ae.S. Boscombe Down Branch lecture, "Supersonic Civil Aircraft," by R. G. Thorne, in the Lecture Hall, A. and A.E.E., at 17.30 hrs.

Derby.—R.Ae.S. Derby Branch lecture, "Silencing of Jet Engines," by F. B. Greatrex, at the Rolls-Royce Welfare Hall, Nightingale Road, at 18.15 hrs.

Henlow.—R.Ae.S. Henlow Branch lecture, "Design for Hypersonic Flight," by H. Metcalfe, in the Assembly Hall, R.A.F. Technical College, at 19.45 hrs.

London.—Society of Instrument Technology lecture, "Data Reduction for Guided Weapon Trials at Aberporth," by A. S. Younger, at Manson House, 26 Portland Place, W.1, at 19.00 hrs.

March 8

Prestwick.—R.Ae.S. Glasgow Branch Graduates' and Students' Section lecture, "Air Traffic Control," by B. Job, at Scottish Aviation, Ltd., at 19.30 hrs.

Gloucester.—R.Ae.S. Gloucester Branch lecture, "Aviation Medicine," by Flt. Lt. J. Billingham, in the Wheatstone Hall, Brunswick Road, at 19.30 hrs.

Salford.—Royal Technical College lecture, "Instrumentation for Research," by J. Ring, at the Royal Technical College, at 19.00 hrs.

London.—R.Ae.S. lecture, "Electro Microcircuits," by Dr. J. W. Granville, in the Library, 4 Hamilton Place, W.1, at 19.00 hrs.

March 9

Chester.—R.Ae.S. Chester Branch Brains Trust in the Lecture Theatre, Grosvenor Museum, at 19.30 hrs.

London.—R.Ae.S. Graduates' and Students' Section lecture, "The Hovercraft and its Development," by W. J. Eggington, in the Library, 4 Hamilton Place, W.1, at 19.30 hrs.

Reading.—R.Ae.S. Reading Branch lecture, "The Applications of Thermo-setting Resins," by E. A. Davies, in the Top Canteen, Western Manufacturing (Reading), Ltd., at 18.00 hrs.

March 10

Bristol.—R.Ae.S. Bristol Branch Barnwell Memorial lecture, "The History of Bristol Aero-Engines," by Sir Roy Fedden, in the Main Lecture Theatre, Faculty of Engineering, University of Bristol, at 19.00 hrs.

Yeovil.—R.Ae.S. Yeovil Branch lecture, "The Philosophy of Patents," by L. Hayward, at Park School, Park Road, at 19.30 hrs.

March 11

London.—R.Ae.S. Symposium on "Vehicle and Instrumentation Problems in Upper Atmosphere Research," all day discussion, at the Institution of Mechanical Engineers, 1 Birdcage Walk, S.W.1, at 09.45 hrs.

New Patents

APPLICATIONS ACCEPTED

832,542.—Zborowski, Von H.P.G.A.R.—"Vertical take-off aircraft."—March 15, 1957. (March 17, 1956.)

832,766.—Youngman, R. T.—"Force balances for instruments."—Mar. 4, 1957. (Mar. 7, 1956.) (Cognate application 16058, May 24, 1956.) (Addition to 700556.)

832,606.—Vickers-Armstrongs (Aircraft), Ltd.—"Aeroplanes."—Jan. 6, 1955. (Feb. 4, 1954.)

832,760.—Vickers-Armstrongs (Aircraft), Ltd.—"Aeroplanes."—Mar. 29, 1955. (Jan. 26, 1954.) (Cognate application 23835, Aug. 16, 1954.)

832,552.—Bristol Aircraft, Ltd.—"Aircraft structures."—Apr. 10, 1958. (Apr. 10, 1957.)

832,761.—Vickers-Armstrongs (Aircraft), Ltd.—"Aeroplanes."—Jan. 4, 1957. (Jan. 18, 1956.) (Cognate application 4322, Feb. 10, 1956.)

832,762.—Vickers-Armstrongs (Aircraft), Ltd.—"Aeroplanes."—Mar. 28, 1956. (Addition to 832,760.)

832,773.—Prewitt Aircraft Co.—"Aircraft structure."—June 14, 1956. (June 30, 1955.)

832,512.—Doak Aircraft Co., Inc.—"Aerodynamic thrust producing devices."—Apr. 30, 1956. (May 2, 1955.)

832,849.—Talco Engineering Co., Inc.—"Vehicle ejection seats."—Oct. 7, 1957.

832,860.—Bendix Aviation Corp.—"Parachute release device."—Nov. 19, 1957.

832,656.—General Motors Corp.—"Aircraft propulsion unit."—Feb. 5, 1958. (Divided out of 832,655.)

832,841.—Goodyear Aircraft Corp.—"Jet engine exhaust thrust reverser."—Sept. 2, 1957. (Oct. 26, 1956.)

Printed specifications of the above will be available on April 13, 1960, and the opposition period will expire on July 13, 1960.

CHANGES OF NAME

Aircraft Bodies, Ltd. (616,076). Homalloy Works, Blackpool Rd., Preston, Lancs.—Name changed to Homalloy (London), Ltd., on September 21, 1959.

Rotorfilms (London), Ltd. (544,835). Crewdson Works, Smallfield Rd., Horley, Surrey—Name changed to Airlift, Ltd., on September 21, 1959.

E. W. Percival Aeronautical Co., Ltd. (388,769). 56 Buckingham Gate, S.W.1.—Name changed to Edgar Percival Aircraft, Ltd., on September 22, 1959.

Personal Notices

BIRTHS

Anderson.—On February 19, at Queen Elizabeth Maternity Unit, King's Lynn, to Diana (*née* Harrod), wife of Flg. Off. D. J. Anderson—a son.

Brownlow.—On February 16, at Louise Margaret Military Hospital, Aldershot, to Kay (*née* Shannon), wife of Sqn. Ldr. B. Brownlow—a daughter.

Corbet.—On February 15, at R.A.F. Hospital, Akrotiri, B.F.P.O. 53, to Isobella (*née* Mackie), wife of Lindsay Corbet—a son.

D'Arcy.—On February 19, at The Louise Margaret Military Hospital, Aldershot, to Isabelle, wife of Flt. Lt. S. H. R. L. D'Arcy—a son.

Harvey.—On February 18, at Paignton and District Hospital, Devon, to Gillian (*née* Riley), wife of Flt. Lt. J. F. Harvey—a son.

Humphrey.—On February 6, at R.A.F. Katunayake, Ceylon, to Janet, wife of Wg. Cdr. Roland Humphrey—a daughter.

McKenzie Pratt.—On February 21, at Princess Mary's R.A.F. Hospital, Halton, to Jean, wife of Sqn. Ldr. McKenzie Pratt—a daughter.

Salmon.—On February 17, at R.A.F. Hospital, Nocton Hall, to Jean (*née* Gibson), wife of Flt. Lt. Robin Salmon—a son.

Shorrock.—On February 8, to Janet, wife of Flt. Lt. A. K. Shorrock—a son.

Wood.—On February 16, at Halton R.A.F. Hospital, to Ann (*née* Colley), wife of Flt. Lt. Geoffrey Wood—a son.

Young.—On February 22, at Salisbury Infirmary, to Pamela, wife of Flt. Lt. R. I. Young—a son.

DEATHS

Byford.—On February 16, Flt. Lt. Graham George Byford.

McCarthy-Jones.—On February 18, Wg. Cdr. Christopher Cecil McCarthy-Jones, O.B.E., A.F.C., R.Aux.A.F.

WEAVER

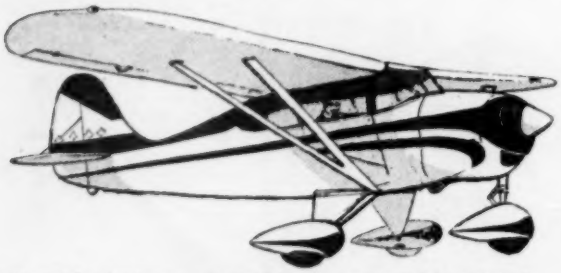
There are no bits in the beehive. No dust, no dirt. Before getting down to production the bees set about the complete elimination of impurities. As with bees, so with AIR BP. BP devotes much time and technical skill in laboratory and field to perfect fuel cleanliness. New equipment developed or adapted by BP engineers already achieves standards far higher than is demanded. Great strides have been made in micro-filtration and water separation to ensure the delivery of the cleanest fuel at the highest rate to aircraft on busy international air routes.

Clean sweep

AIR BP work on these lines continues, aiming at a clean sweep of the minutest contaminants in the service of aviation.

AIR BP

THE AVIATION SERVICE OF BRITISH PETROLEUM



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PIPER TRI-PACER
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